AC-SLRTCE/AC/2025-2026/MOM-01- Item No. 2,3,4 dated 05th July 2025

Shree Rahul Education Society's (Regd.)

SHREE L. R. TIWARI COLLEGE OF ENGINEERING

An Autonomous Institute Affiliated to University of Mumbai,

Approved by AICTE & DTE, Maharashtra State | NAAC Accredited, NBA Accredited Program | ISO 9001:2015 Certified | DTE Code No: 3423 | Recognized under Section 2(f) of the UGC Act 1956 | Minority Status (Hindi Linguistic)

Department of Electronics and Telecommunication

Curriculum FE to BE for A.Y 2025-26

First Year to Final Year Syllabus

Prepared by: Board of Studies for Electronics and Telecommunication

Approved By: Academic Council of Shree L.R. Tiwari College of Engineering

R 2025

PREAMBLE

"Think. Design. Innovate. – Learning that Leads the Future."

SLRTCE is proud to be among the youngest institutions to attain academic autonomy—an achievement that strengthens our commitment to becoming a world-class center for socio- economic development and quality education. It is with great pride and purpose that we introduce the restructured curriculum under academic autonomy at SLRTCE. This initiative marks a significant step toward transforming engineering education by equipping our graduates with strong technical foundations, research acumen, interdisciplinary perspective, and an innovation-driven mindset essential for success in today's evolving professional landscape.

1. Curriculum Design: Theme-Based, Experiential, and Outcome-Oriented

The autonomous curriculum adopts a bottom-up, learner-centric approach aligned with all 12 Program Outcomes. Each semester is driven by a central societal or technological theme, with problem statements rooted in local needs, socio-economic priorities, and the UN Sustainable Development Goals (UNSDGs). Students engage with these challenges through individual projects in the IDEA Lab, integrating social science methodologies with engineering solutions to foster innovation, contextual learning, and socially responsible problem-solving.

2. Purpose of Autonomy: Empowering Innovation and Real-World Learning

Our pursuit of autonomy is rooted in bridging the gap between academic learning and industry relevance. By integrating undergraduate research through the **IDEA Lab**—our dedicated innovation and problem-solving hub—students engage with real-world challenges, apply interdisciplinary knowledge, and develop socially impactful solutions. This approach nurtures engineers who are not only technically sound but also responsible and creative thinkers.

3. Alignment with National Education Policy-2020

Aligned with NEP 2020, the curriculum emphasizes multidisciplinary, hands-on learning. Through theme-based projects, electives, value-added courses, and flexible assessments, SLRTCE ensures holistic student development driven by real-world application and academic rigor. SLRTCE, as a part of Rahul Education, benefits from being in a network of HEIs. All Higher Education Institutions under Rahul Education can collectively contribute to curriculum development, promoting multidisciplinary studies.

4. Innovative Pedagogy Initiative by IQAC

As part of its transformation strategy, IQAC has introduced an innovative pedagogy model centered on interdisciplinary research and contextual problem-solving. The IDEA Lab enables students to apply subject knowledge through socially relevant projects, supported by design thinking and faculty mentorship. A two-tier assessment framework—covering both project execution and subject-wise application—ensures academic depth, continuous mentoring, and quality assurance.

5. Empowering Faculty as Mentors and Innovators

SLRTCE believes that the success of academic autonomy lies in the hands of its faculty. By empowering educators to think beyond conventional boundaries, we enable them to instill Knowledge, Skills, and Attitudes (KSA) in students while enriching their own professional growth. Faculty serve as research mentors and project guides, supported through structured training in innovation pedagogy and assessment.

Sincerely,

IQAC Chairperson
Shree L. R. Tiwari College of Engineering

Chief Operating Officer
Rahul Education

Preface

The Electronics and Telecommunication Engineering (EXTC) program at our autonomous institute under Mumbai University is a dynamic and future-ready course that blends the principles of electronic systems with cutting-edge communication technologies. Designed to empower students with deep technical knowledge and interdisciplinary skills, the program enables innovation across domains such as wireless communication, signal processing, embedded systems, networking, and next-generation communication protocols.

Leveraging our autonomous status, the curriculum is continuously updated to stay at the forefront of technological advancements and evolving industry needs. Key focus areas include 5G and beyond, Internet of Things (IoT), satellite and optical communication, AI-driven networks, and cyber-physical systems — ensuring that students are well-prepared for careers in both core industries and emerging tech sectors.

A distinctive component of the program is the emphasis on experiential learning through labs, design studios, and interdisciplinary project platforms such as the IDEA Lab. This environment fosters creativity, systems thinking, and collaborative problem- solving, allowing students to translate theory into impactful real-world applications.

The EXTC program also embraces a strong commitment to societal relevance and ethical responsibility. Students are encouraged to develop inclusive and sustainable communication solutions aligned with the United Nations Sustainable Development Goals (UN SDGs). Whether it's improving health outcomes through telemedicine (SDG 3), supporting quality education via digital connectivity (SDG 4), enhancing urban resilience with smart infrastructure (SDG 11), or enabling disaster response through resilient communication networks (SDG 13), our students are challenged to innovate with purpose.

Combining rigorous academic training with practical insights, a global perspective, and a strong ethical foundation, the EXTC program cultivates technically proficient, socially conscious engineers ready to lead in a world increasingly defined by intelligent and connected systems.

Mrs. Swapna Patil
Chairperson, Board of Studies (EXTC), SLRTCE

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1. Abbreviations

Abbreviations	
AEC	Ability Enhancement Course
AECL	Ability Enhancement Course Laboratory
AU	Audit Course
BSC	Basic Science Course
BSCL	Basic Science Course Laboratory
CC	Co Curricular Courses
CEP	Community Engagement Project
ELC	Experiential Learning Course
ESC	Engineering Science Course
ESCL	Engineering Science Course Laboratory
HSSM	Humanities Social Sciences and Management
IKS	Indian Knowledge System
INTR	Internship
L	Lecture
LC	Laboratory Course
LLC	Liberal Learning Course
MDM	Multidisciplinary Minor
MDML	Multidisciplinary Minor Laboratory
MJP	Major Project
MP	Mini Project
OE	Open Elective
OJT	On Job Training
P	Practical
PCC	Program Core Course
PEC	Program Elective Course
SBL	Skill Based Laboratory
SEC	Skill Enhancement Course
SL	Self Learning
T	Tutorial
VEC	Value Education Course
VSEC	Vocational and Skill Enhancement Course

2. Curriculum Structure and Examination Scheme for B.E. in Electronics and Telecommunication

(FE with Effect from AY 2025-2026)

Curriculum Structure – FE Semester-I

Course Code	Course Type	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
			L	T	P	L	T	P	SL	Notional Learning Hour	
14111101	BSC	Linear Algebra and Calculus	2	1	--	30	15	--	45	90	3
14111102	BSC	Basics of Semiconductor Physics	2	--	--	30	--	--	30	60	2
14121103	ESC	Basic Electrical and Electronics Engineering	3	--	--	45	--	--	45	90	3
14121104	ESC	Engineering Graphics & Design	2	--	--	30	--	--	30	60	2
14121105	ESC	C and C++ Programming	3	--	--	45	--	--	45	90	3
14112106	BSCL	Basics of Semiconductor Physics Lab	--	--	1	--	--	15	--	15	0.5
14122107	ESCL	Basic Electrical and Electronics Engineering Lab	--	--	2	--	--	30	--	30	1
14122108	ESCL	Engineering Graphics & Design Lab	--	--	2	--	--	30	--	30	1
14122109	ESCL	C and C++ -Programming Lab	--	--	2	--	--	30	--	30	1
14122110	ESCL	IDEA LAB -1(Innovation Design Engineering and Apply)	1	--	2*	15	--	30	15	60	2

14412111	VSEC	Workshop -1	--	--	2	--	–	30	15	45	1.5
98461112	CC	Universal Human Values	2	--	--	30	--	--	30	60	2
98421113	AEC	Enterprise Communication and corporate culture	1	–	–	15	--	–	15	30	1
98422114	AECL	Enterprise Communication And Corporate Culture Lab	–	–	2	–	–	30	–	30	1
		Total	**16**	**1**	**13**	**240**	**15**	**195**	**270**	**720**	**24**

Note:

1) CC will be common to all branches and AEC will be group specific.
2) BSC , ESC and corresponding lab is Department Specific
3) Questions based on self learning must not be asked in internal assessment and End semester Exam
4) *IDEA Lab: The IDEA Lab fosters individual interdisciplinary projects through theme-based, subject-integrated, experiential learning, assessed via standardized rubrics for innovation, application, and documentation.

Notional Learning Hours: In higher education, Notional Learning Hours (NLH) indicates the estimated time that a typical learner, at a specific academic level, is expected to invest in order to achieve the set learning outcomes of a course or module. This time includes a range of structured and independent learning activities, each contributing to the development of knowledge and competencies within a module

Self Learning (SL): Self-learning is integrated into both theory and practical subjects, particularly where practical sessions have only one contact hour per week. It emphasizes student-driven efforts in preparing for assignments, practicals, and examinations. Additionally, self-learning includes topics that go beyond the prescribed syllabus to align with current industry trends and requirements.Assessment of self-learning will follow a formative approach. For theory subjects that include term work, 30% of the assignment questions and student presentations/discussions should be based on self-learning topics. In subjects without term work, the corresponding laboratory sessions will incorporate self-learning, carrying a weightage of 30%. The subject with no termwork and practical will have no assessment on self learning topics. This may involve lab work using the latest tools or preparing technical write-ups/research papers on advanced topics.

Examination Scheme – FE Semester-I

Course Code	Course Type	Course Name	Examination Scheme							Total
			In-Semester Assessments			End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)	Term Work	Practical & Oral	
			IAT-1	IAT-2	Total					
14111101	BSC	Linear Algebra and Calculus	20	20	40	60	2.5	25	–	125
14111102	BSC	Basics of Semiconductor Physics	20	20	40	60	2.5	–	–	100
14121103	ESC	Basic Electrical and Electronics Engineering	20	20	40	60	2.5	–	–	100
14121104	ESC	Engineering Graphics & Design	20	20	40	60	2.5	–	–	100
14121105	ESC	C and C++ -Programming	20	20	40	60	2.5	–	–	100
14112106	BSCL	Basics of Semiconductor Physics Lab	–	–	–	–	–	25	–	25
14122107	ESCL	Basic Electrical and Electronics Engineering Lab	–	–	–	–	–	25	25	50
14122108	ESCL	Engineering Graphics & Design Lab	–	–	–	–	–	25	25	50
14122109	ESCL	C and C++ Programming Lab	–	–	--	–	--	25	25	50

14122110	ESCL	IDEA LAB -1 (Innovation Design Engineering and Apply)	–	–	--	–	--	50	50	100
14412111	VSEC	Workshop -1	–	–	--	--	--	25	–	25
98461112	CC	Universal Human Values	–	–	–	–	–	25	--	25
98421113	AEC	Enterprise Communication and corporate culture	20	20	40	40	1.5	–	--	80
98422114	AECL	Enterprise Communication And Corporate Culture Lab	-	-	-	-	-	25	–	25
		Total	**120**	**120**	**240**	**340**	**14**	**250**	**125**	**955**

Curriculum Structure – FE Semester-II

Course Code	Course Type	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (National Learning Hour/30)
			L	T	P	L	T	P	SL	National Learning Hour	
14111201	BSC	Differential Equations and Integral Calculus	2	1	--	30	15	--	45	90	3
14111202	BSC	Engineering Chemistry for Electronic Components and Materials	2	--	--	30	--	--	30	60	2
14121203	ESC	Engineering Mechanics	2	--	--	30	--	--	30	60	2
14211204	PCC	Elements of Telecommunication	3	–	–	45	--	--	45	90	3
14112205	BSCL	Engineering Chemistry for Electronic Components and Material Lab	–	--	1	--	--	15	–	15	0.5
14122206	ESCL	Engineering Mechanics Lab	–	--	2	--	--	30	–	30	1
14122207	ESCL	Programming Lab (Python)	2	--	2	30	--	30	–	60	2
14122208	ESCL	IDEA LAB -2 (Innovation Design Engineering and Apply)	1	--	2*	15	--	30	15	60	2
14212209	PCCL	Elements of Telecommunication Lab	–	--	2	--	--	30	–	30	1
14412210	VSEC	Workshop - 2	--	--	2	--	--	30	15	45	1.5
98441211	IKS	Indian Knowledge System	2	--	--	30	--	–	30	60	2
98462212	CC	NSS and Civil Defense	–	--	4#	--	--	60	–	60	2
98471213	AU	Audit Course	3	–	–	45	--	--	--	--	--
		Total	**17**	**1**	**15**	**255**	**15**	**225**	**210**	**660**	**22**

Note:

1) IKS and CC will be common to all Branch
2) BSC , ESC and corresponding lab is Department Specific
3) Questions based on self learning must not be asked in internal assessment and End semester Exam
4) *IDEA Lab: The IDEA Lab fosters individual interdisciplinary projects through theme-based, subject-integrated, experiential learning, assessed via standardized rubrics for innovation, application, and documentation.
5)# Students need to complete 60 hours throughout the semester as it is not possible to get 4 hours /week due to the dynamic schedule of the Government agencies.

Notional Learning Hours: In higher education, Notional Learning Hours (NLH) indicates the estimated time that a typical learner, at a specific academic level, is expected to invest in order to achieve the set learning outcomes of a course or module. This time includes a range of structured and independent learning activities, each contributing to the development of knowledge and competencies within a module

Self Learning (SL): Self-learning is integrated into both theory and practical subjects, particularly where practical sessions have only one contact hour per week. It emphasizes student-driven efforts in preparing for assignments, practicals, and examinations. Additionally, self-learning includes topics that go beyond the prescribed syllabus to align with current industry trends and requirements.Assessment of self-learning will follow a formative approach. For theory subjects that include term work, 30% of the assignment questions and student presentations/discussions should be based on self-learning topics. In subjects without term work, the corresponding laboratory sessions will incorporate self-learning, carrying a weightage of 30%. The subject with no termwork and practical will have no assessment on self learning topics. This may involve lab work using the latest tools or preparing technical write-ups/research papers on advanced topics.

Examination Scheme – FE Semester-II

Course Code	Course Type	Course Name	Examination Scheme							Total
			In-Semester Assessments			End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)	Term Work	Practical & Oral	
			IAT-1	IAT-2	Total					
14111201	BSC	Differential Equations and Integral Calculus	20	20	40	60	2.5	25	–	125
14111202	BSC	Engineering Chemistry for Electronic Components and Materials	20	20	40	60	2.5	–	–	100
14121203	ESC	Engineering Mechanics	20	20	40	60	2.5	–	–	100
14211204	PCC	Elements of Telecommunication	20	20	40	60	2.5	–	–	100
14112205	BSCL	Engineering Chemistry for Electronic Components and Materials Lab	–	–	–	–	–	25	–	25
14122206	ESCL	Engineering Mechanics Lab	–	–	–	–	–	25	25	50
14122207	ESCL	Programming Lab (Python)	–	–	–	–	–	25	25	50
14122208	ESCL	IDEA LAB -2 (Innovation Design Engineering and Apply	–	–	--	–	--	50	50	100
14212209	PCCL	Elements of Telecommunication Lab	–	–	--	–	--	25	25	50

14412210	VSEC	Workshop - 2	–	–	--	--	--	25	–	25
98441211	IKS	Indian Knowledge System	20	20	40	60	2.5	--	--	100
98462212	CC	NSS and Civil Defence	-	-	-	-	-	25	--	25
98471213	AU	Audit Course	-	-	-	-	-	-	-	-
		Total	**100**	**100**	**200**	**300**	**12.5**	**225**	**125**	**850**

Curriculum Structure – S.E. Semester-III

Course Code	Course Type	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
			L	T	P	L	T	P	SL	Notional Learning Hour	
14211301	PCC	Mathematics for signal analysis	2	1	–	30	15	–	45	90	3
14211302	PCC	Electronic Devices and Linear Circuits	3	--	--	45	--	--	45	90	3
14211303	PCC	Network Theory and Control system	3	--	–	45	--	--	45	90	3
14211304	PCC	Digital System Design	3	–	–	45	--	--	45	90	3
14212305	PCCL	Analog and Digital Circuits Lab	–	--	2	--	--	30	--	30	1
14212306	PCCL	Skill Lab-Java Programming	–	--	2	--	--	30	--	30	1
9951137WW	OE	To be selected from the bucket proposed by other institute of Rahul Education	2	--	–	30	--	--	30	60	2
98431308	Entrepreneurship	Entrepreneurship Development	2	--	–	30	--	--	30	60	2
98451309	Value education course	Environmental Science	2	--	–	30	--	--	30	60	2
14612310	Community	IDEA LAB -3(Innovation Design	1	--	2*	15	--	30	15	60	2

	engagement Project	Engineering and Apply									
Total			**18**	**1**	**6**	**270**	**15**	**90**	**285**	**660**	**22**

Note:

1) Entrepreneurship and Value education course will be common to all Branch
2) BSC , ESC, PCC and corresponding lab is Department Specific
3) Questions based on self learning must not be asked in internal assessment and End semester Exam
4) *IDEA Lab: The IDEA Lab fosters individual interdisciplinary projects through theme-based, subject-integrated, experiential learning, assessed via standardized rubrics for innovation, application, and documentation.
5) Open Elective: To be selected from the bucket proposed by other institute of Rahul Education

Notional Learning Hours: In higher education, Notional Learning Hours (NLH) indicates the estimated time that a typical learner, at a specific academic level, is expected to invest in order to achieve the set learning outcomes of a course or module. This time includes a range of structured and independent learning activities, each contributing to the development of knowledge and competencies within a module

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Examination Scheme – S.E. Semester-III

Course Type	Course Code	Course Name	Examination Scheme							Total
			In-Semester Assessments			End Sem. Exam (ESE)	Exam Duration for Theory (in Hrs)	Term Work	Practical & Oral	
			IAT-1	IAT-2	TOTAL		End-Sem			
PCC	14211301	Mathematics for signal analysis	20	20	40	60	2.5	25	–	125
PCC	14211302	Electronic Devices and Linear Circuits	20	20	40	60	2.5	–	–	100
PCC	14211303	Network Theory and Control system	20	20	40	60	2.5	–	–	100
PCC	14211304	Digital System Design	20	20	40	60	2.5	–	–	100
PCCL	14212305	Analog and Digital Circuits Lab	–	–	–	–	–	25	25	50
PCCL	14212306	Skill Lab-Java Programming	–	–	–	–	–	25	25	50
OE	9951137WW	To be selected from the bucket proposed by other institute of Rahul Education	–	–	–	–	–	25	–	25
Entrepreneurship	98431308	Entrepreneurship Development	–	–	–	–	–	25	–	25

Value education course	98451309	Environmental Science	20	20	40	60	2.5	–	–	100
Community engagement Project	14612310	IDEA LAB -3(Innovation Design Engineering and Apply	–	–	–	–	–	50	50	100
		Total	**100**	**100**	**200**	**300**	12.5	175	100	**775**

Curriculum Structure—SE Semester-IV

Course code	Course Type	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
			L	T	P	L	T	P	SL	Notional Learning Hour	
14211401	PCC	Sampling Theory and Optimization	2	1	–	30	15	–	45	90	3
14211402	PCC	Analog and Digital communication	3	–	–	45	–	–	45	90	3
14211403	PCC	Microcontroller and Application	3	–	–	45	–	–	45	90	3
14212404	PCCL	Analog and Digital communication Lab	–	–	2	–	–	30	–	30	1
14212405	PCCL	IDEA LAB -4(Innovation Design Engineering and Apply	1	–	2*	15	–	30	15	60	2
14412406	VSEC	Smart Embedded Systems with Atmega 168/328	–	–	2	–	–	30	–	30	1
9931147WW	MDM	To be selected from MDM bucket	3	–	–	45	–	–	45	90	3
9931248WW	MDML	To be selected from MDM bucket	–	–	2	–	–	30	–	30	1

9951149WW	OE	Open Elective	2	–	–	30	–	–	30	60	2
98451410	VEC	Design Thinking	2	–	–	30	–	–	30	60	2
98431411	Entrepreneurship	Business Model Development	2	–	–	30	–	–	30	60	2
98471412	AU	Audit Course	3	–	–	45	–	–	–	–	–
		Total	**21**	**1**	**8**	**315**	**15**	**120**	**285**	**690**	**23**

Note:

1) Entrepreneurship and VEC will be common to all Branch
2) BSC , ESC, PCC and corresponding lab is Department Specific
3) Questions based on self learning must not be asked in internal assessment and End semester Exam
4) *IDEA Lab :The IDEA Lab fosters individual interdisciplinary projects through theme-based, subject-integrated, experiential learning, assessed via standardized rubrics for innovation, application, and documentation.

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Examination Scheme – S.E. Semester-IV

Course Type	Coure Code	Course Name	In-Semester Assessment			End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)	Term Work	Practical & Oral	Total
			IAT-1	IAT-2	Total		End-Sem			
PCC	14211401	Sampling Theory and Optimization	20	20	40	60	2.5	25	–	125
PCC	14211402	Analog and Digital communication	20	20	40	60	2.5	–	–	100
PCC	14211403	Microcontroller and Application	20	20	40	60	2.5	–	–	100
PCCL	14212404	Analog and Digital communication Lab	–	–	–	–	–	25	25	50
PCCL	14212405	IDEA LAB -4(Innovation Design Engineering and Apply	–	–	–	–	–	50	50	100
VSEC	14412406	Smart Embedded Systems with Atmega 168/328	–	–	–	–	–	25	25	50
MDM	9931147 WW	Multidisciplinary Minor	20	20	40	60	2.5	–	–	100
MDML	9931248 WW	Multidisciplinary Minor Lab	–	–	–	–	–	25	25	50
OE	9951149 WW	Open Elective	–	–	–	–	–	25	–	25
VEC	98451410	Design Thinking	20	20	40	60	2.5	–	–	100
Entrepreneurship	98431411	Business Model Development	–	_	–	–	_	25	–	25
		Total	**100**	**100**	**200**	**300**	12.5	200	125	**825**

Curriculum Structure – TE Semester-V

Course Type	Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
			L	P	T	L	P	T	Total
PCC	ETC501	Digital Communication	3	--	--	3	--	--	3
PCC	ETC502	Discrete Time Signal Processing	3	--	--	3	--	--	3
PCC	ETC503	Digital VLSI	3	--	--	3	--	--	3
PCC	ETC504	Random Signal Analysis	3	--	1	3	--	1	4
PECEX	ETC55X	Department Level Optional Course-1	3	--	--	3	--	--	3
PCL	ETL506	Digital Communication Lab	--	2	--	--	1	--	1
PCL	ETL507	Discrete Time Signal Processing Lab	--	2	--	--	1	--	1
PCL	ETL508	Digital VLSI Lab	--	2	--	--	1	--	1
ECL	ETL509	Professional Communication & Ethics-II (PCE-II)	--	2*+2	--	--	2	--	2
ECM	ETL510	Mini Project – 2 A Embedded System Project	--	4$	--	--	2	--	2
		Total	15	16	--	15	7	1	23

Note: $ Indicates work load of a learner (Not Faculty) for Mini Project 2A.
Faculty Load: 1 hour per week per four groups.

Program Elective (PE)-**Department Level Optional Course-1**

Course Code	Course Name
ETC551	Digital and IPTV Engineering
ETC552	Data Compression and Cryptography
ETC553	IT Infra and Security
ETC554	Data Structures and Algorithm
ETC555	Sensor Technology

Examination Scheme – TE Semester-V

Course Type	Course Code	Course Name	Examination Scheme							Total
			In-Semester Assessments			End Sem. Exam (ESE)	Exam Duration for Theory (in Hrs)	Term Work	Practical & Oral	
			IAT-1	IAT-2	Total		End-Sem			
PCC	ETC501	Digital Communication	20	20	40	60	2.5	--	–	100
PCC	ETC502	Discrete Time Signal Processing	20	20	40	60	2.5	–	–	100
PCC	ETC503	Digital VLSI	20	20	40	60	2.5	–	–	100
PCC	ETC504	Random Signal Analysis	20	20	40	60	2.5	25	–	125
PECEX	ETC55X	Department Level Optional Course-1	20	20	40	60	2.5	--	--	100
PCL	ETL506	Digital Communication Lab	--	--	--	--	--	25	25	50
PCL	ETL507	Discrete Time Signal Processing Lab	--	--	--	--	--	25	25	50
PCL	ETL508	Digital VLSI Lab	--	--	--	--	--	25	25	50
ECL	ETL509	Professional Communication & Ethics-II (PCE-II)	--	--	--	--	--	25	25	50
ECM	ETL510	Mini Project – 2 A Embedded System Project	--	--	--	--	--	25	25	50
		Total	--	--	200	300	--	300	125	775

Curriculum Structure – TE Semester-VI

Course Type	Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
			L	P	T	L	P	T	Total
PCC	ETC601	Electromagnetics and Antenna	3	--	--	3	--	--	3
PCC	ETC602	Computer Communication Networks	3	--	--	3	--	--	3
PCC	ETC603	Image Processing and Machine Vision	3	--	--	3	--	--	3
PCC	ETC604	Artificial Neural Network and Fuzzy Logic	3	--	--	3	--	--	3
PECEX	ETC65X	Department Level Optional Course-2	3	--	--	3	--	--	3
PCL	ETL606	Electromagnetics and Antenna Lab	--	2	--	--	1	--	1
PCL	ETL607	Computer Communication Networks Lab	--	2	--	--	1	--	1
PCL	ETL608	Image Processing and Machine Vision Lab	--	2	--	--	1	--	1
PCL	ETL609	Skill Lab: Linux and Networking and Server Configuration	--	4	--	--	2	--	2
ECM	ETL610	Mini Project 2B- FPGA based Project	--	4$	--	--	2	--	2
		Total	**15**	**14**	**--**	**15**	**7**	**--**	**22**

Note: $ Indicates work load of a learner (Not Faculty) for Mini Project 2A.
Faculty Load: 1 hour per week per four groups.

Program Elective– Department Level Optional Course-2

Course Code	Course Name
ETC651	Mixed Signal VLSI
ETC652	Computer Organization and Architecture
ETC653	Digital Forensic
ETC654	Database Management System
ETC655	IoT and Industry 4.0
ETC656	Radar Engineering

Examination Scheme – TE Semester-VI

Course Type	Course Code	Course Name	Examination Scheme							Total
			In-Semester Assessment			End Sem. Exam (ESE)	Exam Duration for Theory (in Hrs)	Term Work	Practical & Oral	
			IAT-1	IAT-2	Total		End-Sem			
PCC	ETC601	Electromagnetics and Antenna	20	20	40	60	2.5	--	–	100
PCC	ETC602	Computer Communication Networks	20	20	40	60	2.5	–	–	100
PCC	ETC603	Image Processing and Machine Vision	20	20	40	60	2.5	–	–	100
PCC	ETC604	Artificial Neural Network and Fuzzy Logic	20	20	40	60	2.5	--	--	100
PECEX	ETC65X	Department Level Optional Course-2	20	20	40	60	2.5	--	--	100
PCL	ETL606	Electromagnetics and Antenna Lab	--	--	--	--	--	25	25	50
PCL	ETL607	Computer Communication Networks Lab	--	--	--	--	--	25	25	50
PCL	ETL608	Image Processing and Machine Vision Lab	--	--	--	--	--	25	25	50
PCL	ETL609	Skill Lab: Linux and Networking and Server Configuration	--	--	--	--	--	25	25	50
ECM	ETL610	Mini Project 2B- FPGA based Project	--	--	--	--	--	25	25	50
		Total	--	--	200	300	--	125	125	750

Curriculum Structure – BE Semester-VII

Course Type	Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
			L	P	T	L	P	T	Total
PCC	ETC701	Microwave Engineering	3	--	--	3	--	--	3
PCC	ETC702	Mobile Communication System	3	--	--	3	--	--	3
PE	ETC73X	Program Elective (PE)– 3	3	--	--	3	--	--	3
PE	ETC74X	Program Elective (PE)– 4	3	--	--	3	--	--	3
OE	OEC75XX	Open Elective - 1	3	--	--	3	--	--	3
PCL	ETL706	Microwave Engineering Laboratory	--	2	--	--	1	--	1
PCL	ETL707	Mobile Communication System Laboratory	--	2	--	--	1	--	1
MJP	ETL708	Major Project-I	--	6*	--	--	2	--	2
		Total	15	10	--	15	4	--	19

Program Elective (PE)– 3 (ETC73X)

Course Code	Course Name
ETC731	Efficient Architectures for DSP Algorithms
ETC732	Deep Learning
ETC733	Cloud Computing and Security
ETC734	Big Data Analytics
ETC735	Software Defined Radio

Program Elective (PE)– 4 (ETC74X**)**

Course Code	Course Name
ETC741	Robotics
ETC742	5G Technology
ETC743	Internet Communication Engineering
ETC744	Advanced Digital Signal Processing
ETC745	Quantum Computing

Open Elective **Course (OE)**

Every student is required to take one **Open Elective** Course for Semester VII, which is not closely allied to their disciplines. Different sets of courses will run in the both
the semesters.

OEC75XX	**Open Elective - 1 (Common for all branches will be notified)**
OEC7501	Product Lifecycle Management
OEC7502	Reliability Engineering
OEC7503	Management Information System
OEC7504	Design of Experiments
OEC7505	Operation Research
OEC7506	Cyber Security and Laws
OEC7507	Disaster Management and Mitigation Measures
OEC7508	Energy Audit and Management
OEC7509	Development Engineering

Examination Scheme – BE Semester-VII

Course Type	Course Code	Course Name	Examination Scheme							Total
			In-Semester Assessment			End Sem. Exam (ESE)	Exam Duration for Theory (in Hrs)	Term Work	Practical & Oral	
			IAT-1	IAT-2	Total		End-Sem			
PCC	ETC701	Microwave Engineering	20	20	40	60	2.5	--	–	100
PCC	ETC702	Mobile Communication System	20	20	40	60	2.5	–	–	100
PE	ETC73X	Program Elective – 3	20	20	40	60	2.5	–	–	100
PE	ETC74X	Program Elective – 4	20	20	40	60	2.5	–	–	100
OE	OEC75XX	Open Elective – 1	20	20	40	60	2.5	--	--	100
PEL	ETL706	Microwave Engineering Laboratory	--	--	--	--	--	25	25	50
PEL	ETL707	Mobile Communication System Laboratory	--	--	--	--	--	25	25	50
MJP	ETL708	Major Project-I	--	--	--	--	--	25	25	50
		Total	--	--	200	300	--	75	75	650

Curriculum Structure – BE Semester-VIII

Course Type	Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
			L	P	T	L	P	T	Total
PCC	ETC801	Optical Communication and Networks	**3**	--	--	**3**	--	--	**3**
PE	ETC82X	Program Elective – 5	**3**	--	--	**3**	--	--	**3**
PE	ETC83X	Program Elective– 6	**3**	--	--	**3**	--	--	**3**
OE	OEC84XX	Open Elective -2	**3**	--	--	**3**	--	--	**3**
PCL	ETL805	Optical Communication and Networks Laboratory	--	2	--	--	1	--	1
MJP	ETL806	Major Project-II	--	**12#**	--	--	**4**	--	**4**
OJT	OJT899	Internship	--	--	--	--	**4**	--	**4**
		Total	**12**	**14**	--	**12**	**8**	--	**21**

Program Elective– 5 (ETC82X)

Course Code	Course Name
ETC821	System On Chip Design
ETC822	Natural Language Processing
ETC823	Wireless Networks
ETC824	Web Design
ETC825	RF Design

Professional Elective– 6 (ETC83X)

Course Code	Course Name
ETC831	Autonomous Vehicle
ETC832	Satellite and Nano Satellite Communication
ETC833	Network Management in Telecommunication
ETC834	Microstrip Antenna
ETC835	Augmented Reality and Virtual Reality

Open Elective **Course (OE)**

Every student is required to take one **Open Elective** Course for Semester VIII, which is not closely allied to their disciplines. Different sets of courses will run in both semesters.

OEC84XX	**Open Elective -2 (Common for all branches will be notified)**
OEC8401	Project Management
OEC8402	Finance Management
OEC8403	Entrepreneurship Development and Management
OEC8404	Human Resource Management
OEC8405	Professional Ethics and CSR
OEC8406	Research Methodology
OEC8407	IPR and Patenting
OEC8408	Digital Business Management
OEC8409	Environmental Management

Examination Scheme – BE Semester-VIII

Course Type	Course Code	Course Name	Examination Scheme							Total
			In-Semester Assessment			End Sem. Exam (ESE)	Exam Duration for Theory (in Hrs)	Term Work	Practical & Oral	
			IAT-1	IAT-2	Total		End-Sem			
PCC	ETC801	Optical Communication and Networks	20	20	40	60	2.5	--	–	100
PE	ETC82X	Program Elective – 5	20	20	40	60	2.5	–	–	100
PE	ETC83X	Program Elective– 6	20	20	40	60	2.5	–	–	100
OE	OEC84XX	Open Elective -2	20	20	40	60	2.5	--	--	100
PCL	ETL805	Optical Communication and Networks Laboratory	--	--	--	--	--	25	25	50
MJP	ETL806	Major Project-II						50	100	150
OJT	OJT899	Internship						25		25
		Total	80	80	160	240	--	100	125	625

Indicative list of Multidisciplinary Minors:

Course Category of Multidisciplinary Minor	Course Code	MDM-I (Semester IV)	MDM-II (Semester V)	MDM-III (Semester VI)	MDM-IV (Semester VI)
Communication Engineering	993114701	Introduction to Telecommunication Systems	Mobile & Wireless Technology for Defence Communication	Telecommunication for Defense Sector	Multidisciplinary Project
	993124802	Introduction to Telecommunication Systems Lab	Mobile & Wireless Technology for Defense Communication Lab	Telecommunication for Defense Sector Lab	Multidisciplinary Project Lab
Internet of Technology	993114703	IOT Sensor Technology	IOT System Design	Dynamic Paradigm in IOT Project	Multidisciplinary Project
	993124804	IOT Sensor Technology Lab	IOT System Design Lab	Dynamic Paradigm in IOT Project Lab	Multidisciplinary Project Lab
Electronics Engineering	993114705	Basic Electronics Circuits	Analog & Digital IC	VLSI and Embedded systems	Multidisciplinary Project
	993124806	Basic Electronics Circuits Lab	Analog & Digital IC Lab	Analog VLSI Lab	Multidisciplinary Project
Mechanical Engineering	993114707	Smart Manufacturing in Assembly Line	Industrial Automation	Cyber Physical System	Multidisciplinary Project
	993124808	Smart Manufacturing Lab	Industrial Automation Lab	Cyber Physical System Lab	Multidisciplinary Project
Sustainability & Environment	993114709	Renewable and Non-Renewable Energy System	Sustainable urban planning development	Geo Informatics	Multidisciplinary Project

	993124810	Renewable and Non-Renewable Energy System Lab	Sustainable urban planning development Lab	Geo Informatics Lab	Multidisciplinary Project
Information Technology	993114711	Agentic AI	Data Engineering	Web Engineering	Multidisciplinary Project
	993124812	Intelligent Agents Lab	Data Engineering Lab	Web Engineering Lab	Multidisciplinary Project
Cyber Security	993114713	Information Security	Cyber Security	Open-Source Intelligence	Multidisciplinary Project
	993124714	Information Security Lab	Cyber Security Lab	Open-Source Intelligence Lab	Multidisciplinary Project
Computer Engineering	993114715	Computational Thinking.	Applied Cryptography	Decentralized technology	Multidisciplinary Project
	993124716	Data Structure Lab	Data Security Lab	Blockchain Lab	Multidisciplinary Project
Artificial Intelligence	993114717	Foundations of Artificial Intelligence	Machine Learning for Engineers	Applied Deep Learning	Multidisciplinary Project
	993124818	Artificial Intelligence Lab	Machine Learning Lab	Deep Learning Lab	Multidisciplinary Project

MDM Sequels for EXTC:

- **Internet of Technology**
- **Electronics Engineering**
- **Mechanical Engineering**
- **Sustainability & Environment**
- **Information Technology**
- **Cyber Security**
- **Computer Engineering**
- **Artificial Intelligence**

MDM Sequels for ECS:

- **Communication Engineering**
- **Internet of Technology**
- **Mechanical Engineering**
- **Sustainability & Environment**

- **Information Technology**
- **Cyber Security**
- **Computer Engineering**
- **Artificial Intelligence**

MDM Sequels for Mechanical:

- **Communication Engineering**
- **Internet of Technology**
- **Electronics Engineering**
- **Sustainability & Environment**
- **Information Technology**
- **Cyber Security**
- **Computer Engineering**
- **Artificial Intelligence**

MDM Sequels for Civil:

- **Communication Engineering**
- **Internet of Technology**
- **Electronics Engineering**
- **Mechanical Engineering**
- **Information Technology**
- **Cyber Security**
- **Computer Engineering**
- **Artificial Intelligence**

MDM Sequels for IT:

- **Communication Engineering**
- **Internet of Technology**
- **Electronics Engineering**
- **Mechanical Engineering**
- **Sustainability & Environment**
- **Cyber Security**
- **Computer Engineering**
- **Artificial Intelligence**

MDM Sequels for CS:

- **Communication Engineering**
- **Internet of Technology**
- **Electronics Engineering**
- **Mechanical Engineering**
- **Sustainability & Environment**
- **Information Technology**
- **Cyber Security**
- **Artificial Intelligence**

Course Code	Course Name	Teaching Scheme (Contact Hours)			Teaching Scheme (Contact Hours Per Semester)					Total
		L	T	P	L	T	P	SL	Notional Learning Hour	
	Open Elective	2	-	-	30	-	-	30	60	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs.)			
		IAT1	IAT2	Total					
	Open Elective	--	--	--	--	--	25	--	25

Students must select a course for Open Elective from a bucket provided by the Rahul Education Group.

Term Work Assessment: 25 Marks (Total marks) = 15 Marks (Case Study/Activity) + 5 Marks (Assignments) + 5 Marks (Attendance)

Internal Assessment and End Semester Exam Question Paper Structure

Internal Assessment for 20 Marks Each:

Internal Assessment (IA) will consists of two compulsory Internal Assessment Test of 20 marks each. IAT-1 is to be conducted on three course outcomes of the syllabus and IAT-2 will be based on remaining three course outcomes. Duration of each test shall be one hour.
Summation of the two tests will be considered as IA marks.

End Semester Examination (60-Marks):

1. Question paper will comprise of total 06 questions, each carrying 10 marks
2. The questions for 10M will be based on each module of the syllabus.
3. All questions from Q No: 01 to Q No:06 will be compulsory and based on entire syllabus.
4. The option will be provided in the question itself like Q No:1 A OR Q no: 1 B Remaining questions will be in similar nature and selected from the respective module.
5. Total 06 questions need to be attempted.

3. F.E Syllabus

Theme: Smart & Sustainable mechanism for Metropolitan Cities

Aligned with UNSDG Goals: - 3: Good Health and Well-being, 4: Quality Education, 7: Affordable and Clean Energy, 9: Industry, Innovation, and Infrastructure, 11: Sustainable Cities and Communities.

Keywords: *Energy conservation, Water management, Waste handling, Environmental monitoring, Efficient resource management in housing societies*

Description:

This semester's theme, "**Smart & Sustainable Mechanisms for Metropolitan Cities**," explores the integration of intelligent technologies and environmentally conscious practices to create efficient, resilient, and livable urban environments. It focuses on how electronics, computing, and applied sciences can be leveraged to address the complex challenges faced by large urban centers. This includes developing innovative solutions that optimize resource consumption **"Smart"** while ensuring long-term ecological balance and societal well-being **"Sustainable"**. The theme aims to equip students with the skills to design systems that contribute to a higher quality of life, reduced environmental impact, and enhanced urban resilience in metropolitan areas.

Students will tackle real-world urban challenges such as energy conservation, water management, waste handling, environmental monitoring, and efficient resource management in housing societies. Through interdisciplinary projects, students will connect theoretical knowledge with practical applications, fostering early-stage engineering thinking and preparing them to develop impactful solutions for sustainable urban development.

Alignment with UNSDG Goals:

UNSDG 3: Good Health and Well-being: The curriculum supports this goal by enabling students to develop foundational smart mechanisms for urban health and safety, such as basic air quality monitoring, noise level detection, or fundamental safety alert systems, contributing to healthier and safer metropolitan living environments.

UNSDG 4: Quality Education: The curriculum fosters quality education by providing hands-on, problem-based learning related to real-world urban challenges. Students gain relevant skills in electronics, computing, and applied sciences, preparing them for careers that contribute to sustainable development.

UNSDG 7: Affordable and Clean Energy: Projects focused on energy conservation, such as smart lighting, directly contribute to more efficient energy use and promote cleaner energy solutions within urban environments.

UNSDG 9: Industry, Innovation, and Infrastructure: This goal is directly addressed by encouraging students to innovate at a foundational level, designing basic components for smart urban infrastructure like traffic flow logic, parking occupancy indicators, and energy monitoring. This fosters early skills crucial for building resilient, sustainable, and technologically advanced city systems.

UNSDG 11: Sustainable Cities and Communities: The overarching theme directly targets this goal by exploring mechanisms for better water management, waste handling, environmental monitoring, and efficient resource management in housing societies, all crucial for creating inclusive, safe, resilient, and sustainable cities.

Problem Statement:

1.Metropolitan areas like Mira Bhayandar face a major challenge with energy waste in common building areas (entrances, lobbies) due to continuously operating traditional lighting. This leads to high costs, light pollution, and a larger carbon footprint, undermining urban sustainability**. (UNSD Goal 11: Sustainable Cities and Communities)**

2.Despite growing adoption of residential solar panels in metropolitan areas like Mira Bhayandar, homeowners lack affordable, real-time monitoring tools for DC power output. This prevents them from effectively tracking energy contribution, identifying inefficiencies, or valuing their clean energy, hindering informed energy management and devaluing renewable investments. (**UNSD Goal 7: Affordable and Clean Energy)**

3. Metropolitan areas like Mira Bhayandar face significant traffic congestion and safety issues due to inefficient traffic control systems. This leads to increased travel times, accident risks, and fuel consumption/emissions, undermining urban mobility, economic productivity, and overall smart/sustainable city development. **(UNSD Goal 11: Sustainable Cities and Communities)**

4.In metropolitan areas like Mira Bhayandar, urban air pollution in public parks poses an invisible threat. The lack of accessible, real-time air quality information prevents public awareness of health risks during outdoor activities, impacting public health and undermining sustainable urban living initiatives. (**UNSD Goal 3: Good Health and Well-being)**

5.In metropolitan areas, escalating parking demand leads to wasted time, fuel, and increased traffic congestion/emissions due to a lack of real-time occupancy information. This hinders efficient urban mobility and undermines smart, sustainable city infrastructure. **(UNSD Goal 9: Industry, Innovation, and Infrastructure)**

6.In dense metropolitan areas like Mira Bhayandar, homes and small businesses lack fundamental, low-cost security monitoring for entry points. This creates vulnerabilities to unauthorized entry, resulting in property loss, disruption, and a diminished sense of safety, as conventional systems are often too expensive or complex for smaller establishments. **(UNSD Goal 11: Sustainable Cities and Communities)**

Theme: Connected Communities through Intelligent Systems and Sustainable Design.

- UNSDG 3: Good Health and Well-being
- UNSDG 6: Clean Water and Sanitation
- UNSDG 7: Affordable and Clean Energy
- UNSDG 9: Industry, Innovation and Infrastructure
- UNSDG 11: Sustainable Cities and Communities
- UNSDG 16: Peace, Justice, and Strong Institutions

Keywords: *Digital entry system, FSM (Finite State Machine), Keypad access, Affordable security, Residential automation, Community safety, Sustainable Cities*

Description:

The theme "Connected Communities through Intelligent Systems and Sustainable Design" emphasizes the development of low-cost, scalable technologies that foster smarter and more inclusive suburban living. In suburban areas across Mumbai—such as Mira Road, Dombivli, Vasai, and Kurla communities face everyday challenges ranging from insecure entry systems in housing societies, to unmanaged traffic signals, water overflow in tanks, and food wastage in schools and hostels. These localized issues, often overlooked, stem from a lack of simple, tech-enabled solutions rooted in community needs. By integrating digital logic, sensor-based automation, and Python-driven control systems, students work toward solving these real-world problems. This theme directly supports UN Sustainable Development Goals focused on clean energy, sustainable cities, quality education, clean water, and community well-being—driving engineering practice toward socially responsible innovation.

Problem Statements:

1. In many densely populated suburban and urban areas, residential communities often lack automated entry systems. Manual gate operations and the high cost of commercial security solutions pose challenges for these neighborhoods in adopting modern and efficient security measures.
2. Intersections in many suburban and urban areas often experience traffic congestion and safety issues due to outdated or manually operated traffic control systems. This results in irregular traffic flow, longer commute times, and a higher risk of accidents.
3. In areas with unreliable electricity supply, such as Vasai and Nalasopara, streetlights are frequently left on during daylight hours due to the lack of automated control systems. This results in unnecessary energy wastage and higher maintenance and operational costs.
4. In many urban neighborhoods, overflow from overhead water tanks is a common problem, causing substantial water wastage and potential structural damage due to dampness.
5. Educational institutions in many areas struggle to maintain timely class schedules due to dependence on manual bell systems. This often leads to time mismanagement and interruptions in the academic routine.
6. In many suburban regions, students who commute by bicycle often encounter a lack of secure parking facilities on educational campuses. The absence of proper locking infrastructure raises the risk of theft and discourages the use of environmentally friendly transportation options.

R-2025- F.E Electronics and Telecommunication Engineering

Course Code	Course Name	Teaching Scheme (Contact Hours Per week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14111101	Linear Algebra and Calculus	2	1	--	30	15	--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-1	IAT-2	Total					
14111101	Linear Algebra and Calculus	20	20	40	60	2.5	25	--	125

Rationale:

A solid mathematical foundation is crucial for first-year Electronics and Telecommunication Engineering students to effectively analyze and design complex engineering systems. The integrated study of matrices and linear equations enables students to model and solve multiple simultaneous relationships frequently encountered in circuit analysis and communication systems, such as in MIMO wireless technologies. Understanding eigenvalues, eigenvectors, and matrix diagonalization provides essential insights into system stability, natural frequencies, and the simplification of dynamic system models used extensively in control engineering and signal processing. Partial differentiation equips students to analyze how system parameters vary with respect to multiple variables, which is fundamental in studying electromagnetic fields, sensor operations, and signal variations in space and time. Moreover, the use of complex variables and analytic functions forms the basis for representing and analyzing alternating current (AC) circuits and sinusoidal signals through phasors, thereby facilitating impedance analysis, resonance, and wave propagation critical to telecommunication networks. Collectively, these mathematical tools prepare students to address practical engineering challenges and lay the groundwork for advanced studies in electronics and telecommunication engineering.

R-2025- F.E Electronics and Telecommunication Engineering

Course Objectives:

1. To introduce matrix operations used in modeling systems and digital circuits.
2. To equip students with techniques to solve systems of linear equations used in circuit analysis and network theory.
3. To develop the ability to compute eigenvalues and eigenvectors used in stability analysis and signal processing.
4. To understand matrix diagonalization for simplifying complex systems in filter design and digital signal processing (DSP).
5. To introduce partial differentiation for analyzing functions with multiple variables, common in electromagnetic field theory.
6. To understand analytic functions and their properties for applications in signal modulation and AC circuit analysis.

Course Outcomes:

1. Students will be able to solve matrix problems and apply them and use SCILAB to system representations such as MIMO antenna systems.

2. Students will be able to solve systems of linear equations and apply them and use SCILAB to analyze electrical networks.

3. Students will be able to determine eigenvalues/eigenvectors and apply them and use SCILAB in system stability and filter design.

4. Students will be able to diagonalize matrices and use them and use SCILAB to simplify system behavior in control and DSP applications.

5. Students will be able to apply partial derivatives to analyze functions and use SCILAB in fields such as electromagnetics.

6. Students will be able to identify and construct analytic functions, and apply them and use SCILAB to model AC circuit behavior using phasors.

Prerequisite:

1. Addition, multiplication, transpose, and inverse of a matrix**.**

2. Review of Complex Numbers-Algebra of Complex Numbers, Cartesian, polar and exponential form of complex number.

R-2025- F.E Electronics and Telecommunication Engineering

DETAILED SYLLABUS: total six module for each subject (15 Weeks)

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	Matrices	Types of Matrices (Symmetric, Skew- symmetric, Hermitian, Skew-Hermitian, unitary, orthogonal matrices and properties of matrices).	05	CO1
		Rank of a matrix using Echelon form, reduction to normal form and PAQ form.		
		Application of matrices to Coding and De-coding		
		Self-learning Topics: 1. PAQ form for rectangular matrices. 2. Reduction to normal form. 3. Theorems on sum of symmetric and skew symmetric matrices and similar theorems. 4. Properties of transpose, conjugate of matrices	07	
II	System of Linear Equations	System of Linear homogeneous and non–homogeneous equations, their consistency and solutions using rank.	05	CO2
		Linear dependence and independence of vectors. Linear combination of vectors		
		Solution of a system of linear algebraic equations, by (i) Gauss Jacobi Iteration Method, (ii) Gauss Seidel Iteration Method.		
		Self-learning Topics: 1. Vector Spaces 2. Linear Transformations. 3. Rank -Nullity theorems.	08	

R-2025- F.E Electronics and Telecommunication Engineering

III	Eigen values and Eigen vectors	Eigenvalues & eigenvectors of all types of matrices (symmetric, skew symmetric, orthogonal, triangular) and its properties (without proof).	05	CO3
		Cayley-Hamilton Theorem (without proof), verification and reduction of higher degree polynomials		
		Self-learning Topics: 1. Quadratic forms. 2. Reduction to quadratic forms 3. Rank, signature and index of a quadratic forms	08	
IV	Similarity and diagonalization of matrix	Similar matrices, diagonalizable matrices, orthogonally diagonalizable matrices and functions of square matrix.	05	CO4
		Minimal polynomial, Derogatory and non-derogatory matrices.		
		Singular value decomposition (SVD)		
		Self-learning Topics: 1. Functions of Square Matrix 2. Orthogonally diagonalization.	07	
V	Partial Differentiation	Function of two and three variables, Partial derivatives of first and higher order. Differentiation of composite function.	05	CO5
		Maxima and Minima of a function of two independent variables.		
		Lagrange's Multiplier method with one condition.		
		Self-learning Topics: 1. Euler's Theorem on Homogeneous functions with two independent variables. 2. Euler's Theorem on Homogeneous functions with three independent variables.	08	

		3. Deductions from Euler's Theorem. 4. Total differentials 5. Implicit Functions		
VI	Complex Variables – Differentiation	Circular functions of complex number and Hyperbolic functions. Analytic function, necessary and sufficient conditions for f(z) to be analytic (without proof),		
		Cauchy-Riemann equations in Cartesian coordinates (without proof, Polar form not included)	05	CO6
		Milne-Thomson method to determine analytic function f(z) when real (u)or imaginary part (v) is given.		
		Harmonic function, Harmonic conjugate, and orthogonal trajectories.		
		Self-learning Topics: 1. Expansion of $\sin^n\theta$, $\cos^n\theta$ in terms of sines and cosines of multiples of θ and Expansion of sinnθ, cosnθ in powers of sinθ, cosθ. 2. Powers and Roots of a complex number. 3. Logarithm of Complex Number 4. Inverse Hyperbolic Functions. Separation of real and imaginary parts of all types of Functions.	07	

Text Books:

1. Grewal B. S.: "Higher Engineering Mathematics", Khanna Publishers, 44th Ed., 2021.

2. Kreyszig E.: "Advanced Engineering Mathematics", John Wiley & Sons, 10th Ed., 2018.

3. Dass H. K.: "Higher Engineering Mathematics", S Chand & Company Ltd, 12th Ed., 2004.

4. Narayan S.: "Differential Calculus", S.Chand Publications, 30th Ed., 2005.

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1. Strang G.: "Linear Algebra and its Applications", Cengage Publications, 4th Ed. 2022.
2. Stewart J.: "Multivariable Calculus" Cengage Publications, 7th Ed., 2019.
3. Jain M.K., Iyengar SRK, Jain R K,: "Numerical Methods for Scientific and Engineering Computation", New Age International Publishers, 6th Ed., 2007.
4. Bali N.P and Goyal M.: "A Textbook of Engineering Mathematics" Laxmi Publications, 10th Ed., 2022.
5. Williams G.: "Linear Algebra with Applications", Jones Bartlett Publishers Inc., 6th Ed., 2017.
6. Wylie C. R, Barrett L.C..: "Advanced Engineering Mathematics" McGraw Hill Book Co., New York, 6th Ed., 2017.
7. Ramana B.V.: "Higher Engineering Mathematics", Tata McGraw-Hill Publishing Company Limited, 1st Ed., 2006.
8. Gupta C.B, Sing S.R and Mukesh Kumar: "Engineering Mathematic for Semester I and II", Mc-Graw Hill Education, 2015.
9. Lay D. C: "Linear Algebra and its Applications", Pearson Publishers, 4th Ed., 2018.
10. Pal S. & Bhunia S. C.: "Engineering Mathematics" Oxford University Press, 3rd Ed., 2016

Online References:

Sr. No.	Website Name
1.	https://www.math.ucdavis.edu/~daddel/linear_algebra_appl/Applications/applications.html
2.	https://onlinelibrary.wiley.com/doi/10.1155/2016/4854759
3.	https://archive.nptel.ac.in/courses/111/108/111108066/
4.	https://archive.nptel.ac.in/courses/111/104/111104092/

Assessment:

Term work (TW) for 25 marks:

1. Batch-wise tutorials are to be conducted.

2. Students must be encouraged to write SCILAB Programs in tutorial class only. Each Student has to write **at least 5 SCILAB tutorials** (including print out) and **at least 10** class tutorials on entire syllabus.

3. SCILAB Tutorials will be based on entire syllabus

The distribution of Term Work marks will be as follows –

1. Regularity and active involvement (Theory and Tutorial) 05 marks

2. Class Tutorials on entire syllabus 10 marks

3. SCILAB Tutorials 10 marks

R-2025- F.E Electronics and Telecommunication Engineering

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					
		L	T	P	L	T	P	SL	Notional Learning Hour	Total Credits (C) Notional Learning Hour/30
14111102	Basics of Semiconductor Physics	2		--	30	-	--	30	60	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT-1	IAT-2	Total					
14111102	Basics of Semiconductor Physics	20	20	40	60	2.5	--	--	100

Rationale: The syllabus for Electronics and Telecommunication Engineering (EXTC) and Electronics and Computer Science (ECS) branches is structured to provide a strong theoretical and practical foundation in semiconductor physics, electronic devices, circuit analysis, and emerging technologies. Core topics such as diodes, transistors, FETs, and nanotechnology are included to help students understand the working principles of modern electronic systems. The inclusion of device applications and modern trends like MOSFETs and Hall Effect ensures students are aligned with current industry practices and prepared for advanced studies in communication systems, embedded electronics, and computational electronics.

Course Objectives:

1. To introduce the fundamental concepts of semiconductors and carrier behaviour in intrinsic and extrinsic materials.
2. To explain the working principles and characteristics of p-n junction diodes.
3. To familiarize students with the construction, types, and applications of special-purpose diodes.
4. To study the operation, characteristics, and switching behaviour of Bipolar Junction Transistors (BJTs).
5. To understand the structure, functioning, and application of Field Effect Transistors (JFETs and MOSFETs).
6. To introduce nanotechnology concepts, material properties at the nanoscale, and their applications in electronics.

Course Outcomes:

1. **EXPLAIN** how charge carriers behave in intrinsic and extrinsic semiconductors and **CALCULATE** their concentrations using basic formulas.
2. **DESCRIBE** how a p-n junction is formed, **DERIVE** the diode equation, and **ANALYZE** how current and voltage change in different bias conditions.
3. **CLASSIFY** different special-purpose diodes and **EXPLAIN** how they work and where they are used.
4. **INTERPRET** how BJTs work in different circuits and **EXPLAIN** their role in amplification and switching.
5. **COMPARE** JFET and MOSFET structures and **APPLY** MOSFETs in simple switching applications.
6. **SUMMARIZE** the basics of nanotechnology and **IDENTIFY** how it's used in making modern electronic devices.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
	Prerequisite	Basic understanding of atomic structure and energy bands in solids Knowledge of conductors, insulators, and semiconductors Familiarity with Ohm's Law, resistance, and electrical circuits Concept of current, voltage, power, and energy in electrical systems Basic idea of magnetic fields and electromagnetic induction		
	Introduction to Semiconductors	Direct and Indirect Semiconductors, Carrier Concentration in Intrinsic Semiconductors, Fermi Level of Intrinsic Semiconductors, Variation of Fermi Level of Intrinsic Semiconductors with respect to Temperature, Extrinsic Semiconductors, Fermi Level of Extrinsic Semiconductors, Variation of Fermi Level of Extrinsic Semiconductors with respect to Temperature and Impurity Concentration, Equation of Conductivity with Current Flow, Hall Effect, Calculation of Hall Voltage.	06	CO1
		Self-Learning: Energy band diagrams of metals, insulators, and semiconductors Drift current and diffusion current in semiconductors Applications of Hall Effect in sensor design and material characterization Real-life examples of intrinsic and extrinsic semiconductors (e.g., Silicon, Germanium, GaAs), Basics	06	

		of semiconductor material fabrication (crystal growth, doping techniques)		
2	Junction Diode Physics and Characteristics	Formation of p-n junction, calculation of barrier potential Diode equation, p-n junction in forward Bias, p-n junction in Reverse bias, Current- voltage curve for p-n junction diode, Derivation of barrier potential.	05	CO2
		Self-Learning: Breakdown mechanisms in p-n junctions: Zener and Avalanche breakdown, Diode dynamic (AC) resistance and static (DC) resistance Capacitance effects in p-n junctions (transition and diffusion capacitance) Applications of diodes in logic circuits and voltage multipliers	05	
3	Functional Diodes and Optoelectronic Devices	Study of concept and working of various important diodes such as Zener diode, Light Emitting Diode (LED), Photodiode, Solar Cell, Varactor diode, Gunn diode, Tunnel diode, Schottky diode, PIN diode, Avalanche diode, Laser diode, Shockley diode, and Step Recovery diode.	05	CO3
		Self-Learning: Material science behind LED color variations (bandgap and emission spectrum), photodiode response time and noise characteristics, applications of varactor diodes in frequency modulation and tuning circuits, negative resistance property in Gunn and Tunnel diodes, PIN diode usage in RF attenuators and switches, use of avalanche diodes in ESD	05	

		(Electrostatic Discharge) protection circuit.		
4	Transistor Operation and Applications	BJT Structure and Operation - BJT structure, Modes of operation,CB, CE I-V characteristics BJT Amplification and Switching - Current gain, BJT as a switch	05	CO4
		Self-Learning: Configurations (CB, CE, CC) and their comparisons, load line analysis and Q-point stability, transistor biasing techniques and their practical importance BJT switching speed and delay factors, real-life applications of BJT in amplifier and logic circuits.	05	
5	Field Effect Transistors	Field Effect Transistors – Introduction to FETs, types of FETs: JFET and MOSFET, structure and operation. Detailed study of MOSFETs – MOSFET structure, enhancement mode and depletion mode operation, threshold voltage. Applications of MOSFET – MOSFET as a switch.	06	CO5
		Self-Learning: Comparison between JFET and MOSFET characteristics, graphical analysis of transfer and output characteristics of FETs, significance of threshold voltage in switching applications, CMOS basics and role of MOSFETs in CMOS logic circuits.	06	
6	Nanotechnology	Introduction to Nanotechnology, Properties (optical, Electrical, Structural, Mechanical) Importance of surface to Volume ratio, nanofabrication techniques such as chemical vapor deposition,	03	CO6

		Application: Lithography, Single Electron Transfer (SET), Spin Valves.		
		Self-Learning: Difference between bulk and nanoscale materials, effect of reduced dimensions on physical properties, classification of nanomaterials (0D, 1D, 2D, 3D), role of quantum confinement in optical and electrical behavior of nanomaterials, real-world applications of SET and spintronics devices, basics of nanolithography and its use in semiconductor industries.	03	
	Total		60	

Text Books:

1. Engineering Physics by D.K Bhttacharya, PoonamTandon - Oxford University Press
2. Solid State Electronic Devices – B. G. Streetman – Pearson
3. Electronic Devices and Circuits – Homas Floyd – Pearson
4. Electronic Devices and Circuits – David A. Bell – Oxford University

References:

1. Semiconductor Physics and Devices – Basic Principles – Donald Neamen – McGraw Hill
2. Physics of Semiconductor Devices - S.M. Sze, Kwok K. Ng - John Wiley & Sons
3. Electronic Devices and Circuit Theory - R. Boylestad, L Nashelsky - Pearson

Online References:

Sr. No.	Website Name
1.	https://archive.nptel.ac.in/courses/108/108/108108122/
2.	https://onlinecourses.nptel.ac.in/noc22_ee97/preview
3.	https://www.optima.ufam.edu.br/SemPhys/Downloads/Neamen.pdf

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					
		L	T	P	L	T	P	SL	Notional Learning Hour	Total Credits (C) Notional Learning Hour/30
14121103	Basic Electrical and Electronics Engineering	3		--	45	-	--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT-1	IAT-2	Total					
14121103	Basic Electrical and Electronics Engineering	20	20	40	60	2.5	--	--	100

Rationale: This course provides foundational knowledge of electrical and electronic principles essential for all engineering disciplines. It covers basic circuit theory, electrical machines, and electronic components like diodes, transistors. Understanding these fundamentals enables students to analyze and troubleshoot simple electrical systems and prepares them for advanced topics in automation, communication, and embedded systems. The course supports interdisciplinary learning and develops essential problem-solving skills for real-world engineering applications.

Course Objectives:

1. To enable students to **understand** the fundamental concepts of direct current (DC) circuits,

including Ohm's Law, Kirchhoff's Laws, and basic circuit components, and apply them to analyze and solve simple electrical networks.

2. To enable students to **explore** the principles of alternating current (AC) in single-phase and three-phase circuits, including the concepts of RMS value, power factor, and power measurement.
3. To enable students to **identify** the construction, working principle, and applications of a single-phase transformer, along with its efficiency
4. To enable students to **relate** the principles of electromagnetic induction to the operation of various electrical machines like DC machines, induction motors
5. To enable students to **promote** understanding of the working principles and applications of semiconductor devices like diodes and transistors, and their role in amplifier circuits.
6. To enable students to **encourage** to understand the basics of digital systems, including number systems and logic gates, to build a strong foundation in digital electronics

Course Outcomes:

1. **Apply** Ohm's Law, Kirchhoff's Laws, and network theorems like Thevenin's, Norton's, and Superposition to analyze DC circuits in electronic systems
2. **Analyze** single and three-phase AC circuits using phasor diagrams, impedance, and power factor to evaluate voltage, current, and power in various configurations.
3. **Explain** the construction, working principle, and equivalent circuit of a single-phase transformer, including its performance parameters such as efficiency
4. **Illustrate** the construction, working principles, and applications of basic electrical machines such as DC machines and AC motors.
5. **Evaluate** the characteristics and applications of semiconductor devices such as PN junction diode, Zener diode, and BJT in electronic circuits.
6. **Demonstrate** the operation of basic digital circuits using logic gates, Boolean algebra.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
	Prerequisite	Resistance, inductance, capacitance, series and parallel connection of resistance, concept of voltage, current, power and energy and its units, magnetic circuit, mmf, magnetic field strength, reluctance.		

1	DC Circuits	D.C. circuits and network simplification: series and parallel circuits, Kirchhoff's laws, mesh and nodal analysis. star-delta transformation, Mesh and Nodal Analysis, Source transformation Superposition theorem, Thevenin's theorem, Norton's theorem, maximum power transfer theorem	14	CO1
		Self-Learning: Basic electrical quantities: voltage, current, resistance, and power. Ohm's Law, Kirchhoff's laws, and sign conventions Algebra and solving linear equations, basic network terms (node, branch, loop)	14	
2	AC circuits (Single phase and Three Phase system)	Generation of alternating voltage & current (AC), fundamentals of AC - waveforms, Phasor representation of AC quantities, definitions of time period, amplitude, frequency, phase, RMS value and average value, Peak factor and Form Factor. R, L, C in AC circuits, Series RL, RC and RLC circuits- phase difference and power factor, phasor diagram, series-parallel circuits, active, reactive, apparent power, series resonance. Generation of three-phase voltages, voltage & current relationships in star and delta connections.	16	CO2
		Self-Learning: **AC Waveforms & Parameters** – Sine wave, frequency, time period, amplitude **Phasor Representation** – Vector form of AC quantities **RMS & Average Values** – Definitions, formulas, practical significance	16	

		Peak Factor & Form Factor – Understanding waveform shapes		
3	Single Phase Transformers	Working principle of single-phase transformer, emf equation of a transformer, transformer losses, actual (practical) and ideal transformer, overview of efficiency	03	CO3
		Self-Learning: Working principle and EMF equation of a transformer Transformer losses: core and copper losses Ideal vs. practical transformer. Transformer efficiency and load conditions. Role of transformers in power systems.	03	
4	Electrical Machines	Construction, principle of operation, classification of DC machines, applications of DC generator, DC motor, equation of generated emf/back emf Fundamental principles of rotating machines, construction, working principle and applications of stepper and servo motor	03	CO4
		Self-Learning : Construction, operation, and classification of DC machines EMF and back emf equations in DC machines Basics of rotating machines Stepper and servo motors: construction, working, applications	03	
5	Semiconductor Devices	Semiconductor Basics, Construction, operation and characteristics of PN junction diode, zener diode and bipolar junction transistor.	04	CO5
		Self-Learning	04	

		Semiconductor fundamentals: types and properties PN junction diode: construction, operation, and I-V characteristics Zener diode: construction, operation, and voltage regulation Bipolar Junction Transistor (BJT): structure, working, and characteristics		
6	Fundamentals of digital circuits	Number System: Binary, octal, decimal, hexadecimal, their conversion, and arithmetic (binary addition, subtraction using 1's & 2's complement) Logic Gates: AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR universal gates. Boolean algebra, DE Morgan's theorem	05	CO6
		Self-Learning: Number systems and conversions Binary addition and subtraction (1's & 2's complement) Boolean algebra basics	05	
	Total		90	

Text Books:

1. B. L. Theraja – Textbook of Electrical Technology, Prentice Hall of India (PHI)
2. B.R Patil – Basic Electrical Engineering, Oxford Higher Education
3. V. N. Mittal and Arvind Mittal – Basic Electrical Engineering, Tata McGraw Hill
4. V. K. Mehta – Principles of Electronics, S. Chand Publishing, New Delhi 7
5. R. S. Sedha – A Textbook of Applied Electronics, S. Chand Publishing, New Delhi
6. Digital Fundamental, 8th edition, Floyd and Jain, Pearson Education India, 2005
7. Electric Motors and Drives Fundamentals, Types and Applications, 3 rd Edition, Austin Hughes, Newnes Publisher.

References:

1. Introduction to Electrical Engineering, M. Naidu, S. Kamakshaiah, McGraw-Hill Education, 2004
2. S. N. Singh, "Basic Electrical Engineering" PHI, 2011

3. Electrical and Electronic Technology, 10th edition Edward Hughes, Pearson Education.

Online References:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/108108076
2.	https://www.nesoacademy.org/ec/04-analog-electronics/02-semiconductor-diode/01-pn-junction-diode-no-applied-bias
3.	https://onlinecourses.nptel.ac.in/noc21_ee55/preview
4.	https://onlinecourses.nptel.ac.in/noc20_ee60/preview
5.	https://archive.nptel.ac.in/courses/108/105/108105113/

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14121104	Engineering Graphics & Design	2	-	-	30	-	-	-	30	2

Course Code	Course Name	Theory					Term work	Prac / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT-1	IAT-2	Total					
14121104	Engineering Graphics & Design	20	20	40	60	2.5	--	--	100

Rationale:

Engineering Graphics develops spatial visualization and technical drawing skills essential for modern computing applications. It bridges the gap between digital systems and the physical world, supporting areas like embedded systems, IoT, and robotics. The course enhances understanding of 3D modeling, essential for AR/VR, digital twins, and simulation-based tools. It prepares students to work effectively in interdisciplinary teams involving hardware-software integration. Concepts like projections and solid modeling are foundational for CAD software, PCB design, and interface development. It supports UI/UX development for 3D applications, gaming, and visualization platforms. Engineering graphics aids in documenting and communicating design ideas clearly and accurately. Overall, it fosters analytical thinking and design communication, crucial for innovation in intelligent computing systems.

Course Objectives

1	To impart and inculcate proper understanding of the theory of projection.
2	To impart the knowledge to read and interpret a drawing.
3	To improve the visualization skill.
4	To enable students to represent three-dimensional objects on a two-dimensional surface in a way that accurately conveys their shape, size, and orientation.
5	To acquaint students with representing internal features of a three-dimensional object by way of section that accurately conveys their internal orientation.

Course Outcomes

1	Apply basic concepts of geometrical constructions to create engineering curves.
2	Apply the basic principles of projections in Projection of Lines and Planes
3	Apply the basic principles of projections in Projection of Solids.
4	Apply the basic principles of sectional views in Section of solids.
5	Apply the basic principles of projections in converting pictorial views into orthographic Views.
6	Apply the basic principles of projections in converting orthographic views into isometric drawing.

Detailed Syllabus

Module no.	Module Name	Detailed content	Teaching hours	CO
	Prerequisite	To draw basic geometric shapes like circle, pentagon, hexagon, and square with different orientation. Divide a line, circle, etc. into equal number of parts.	01	
1	**Introduction to Engineering Drawing and Engineering curves**	**1.1** Introduction to Engineering Graphics and its significance in the Engineering domain. **1.2** Types of Lines, Dimensioning Systems as per IS conventions. **1.3 Engineering Curves**: Basic construction of Conics, Cycloid, Involutes and Helix (cylinder only). **Self-learning topic:** - Explore the concepts of eccentricity, focus, vertex, axis, directrix	03 03	CO 1

		- Explore other conics - ellipse, parabola and hyperbola using directrix-focus method		
2	**Projections of Points, Lines and Planes**	**2.1 Projections of points** in all four quadrants as well as lying on the planes. **2.2 Projections of lines** inclined to both the reference planes (Excluding Traces of lines). Simple application-based problems on projection of lines. **2.3 Projection of planes** (only standard geometrical shapes like square, triangle, pentagon, circle, etc.) inclined to one of the reference planes only. **Self-learning topic:** - Explore the projection of lines for mixed quadrants - Explore the projection of planes for planes inclined to both the reference planes	05 05	CO 2
3	**Projections of Solids**	**3.1** Projections of solids with the axis inclined to one reference plane include prism and cylinder **3.2** Projections of solids with the axis inclined to both reference planes include pyramid, and cone (Use change of position or Auxiliary plane method) **Self-learning topic:** - Explore the cuboid and tetrahedron solids inclined to one or both the reference planes. - Explore the applications of solid projection in machine components, structure, and packaging and manufacturing.	06 06	CO 3
4	**Sections of Solids and Development of Surfaces**	**Sections of Solids** Sections of Prism, Pyramid, Cylinder, & Cone cut by plane perpendicular to only one reference plane. Use change of position or Auxiliary plane method. **Self-learning topics:** - Explore the development of lateral surface for regular solids - Prism, Pyramid, Cylinder, & Cone - Explore the real-life application of solids cut with section planes inclined to one plane.	04 04	CO 4
5	**Orthographic and Sectional Orthographic Projections**	Fundamental concepts of orthographic and sectional orthographic projections like Positioning of quadrants, observer, horizontal, vertical and profile plane, symbol etc., Different orthographic views, First and Third angle method of projection, different section (cutting) plane, its		CO 5

		representation, importance of sectional views, rib and web in section. Views of simple machine parts as per the first angle projection method recommended by I.S. for Orthographic and Sectional Orthographic projection **Self-learning topics:** - Explore the third angle method of projection for orthographic views. - Explore half sectional and offset sectional views - Practice simple machine components with half section and offset section	06 06	
6	**Isometric Views**	Introduction to isometric projections and Fundamental concepts of Isometric projection - isometric and non-isometric lines, axes, and planes. Concept of isometric scale. Difference between isometric projection and isometric views. Conversion of orthographic views to isometric views **Self-learning topics:** - Explore the concepts of isometric scale and isometric projection - Practice isometric projection of simple objects using isometric scale - Explore the isometric views and projections of holes and slots on an inclined plane	05 05	CO 6

Text Books:

1. N.D. Bhatt, "Engineering Drawing (Plane and solid geometry)", Charotar Publishing House Pvt.
Ltd.
2. N.D. Bhatt & V.M. Panchal, "Machine Drawing", Charotar Publishing House Pvt. Ltd.

References:

1. Narayana, K.L. & P Kannaiah (2008), Textbook on Engineering Drawing, Scitech Publisher.
2. Prof. Sham Tickoo (Purdue University) & Gaurav Verma, "(CAD Soft Technologies).
3. Auto CAD 2012 (For engineers and Designers)", Dreamtech Press New Delhi.
4. Dhananjay A Jolhe, "Engineering Drawing" Tata McGraw Hill.

Online References:

Sr. No.	Website Name
1	https://archive.nptel.ac.in/courses/112/105/112105294/
2	https://nptel.ac.in/courses/112103019
3	https://archive.nptel.ac.in/courses/112/102/112102304/

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
14121105	C and C++ Programming	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac / Oral	Total
		Internal Assessment Test (IAT)			End Sem Exam	Exam Duration in Hrs.			
		IAT -1	IAT-2	Total					
14121105	C and C++ Programming	20	20	40	60	2.5	--	--	100

Rationale:

The C and C++ Programming course serves as a foundational pillar for first-year engineering students across all branches by developing essential problem-solving and programming skills. It introduces students to both structured and object-oriented programming paradigms, fostering logical thinking and algorithmic design. As C is widely used in system-level programming and C++ forms the basis for modern software development, this course ensures students gain proficiency in writing efficient, modular, and scalable code. Its relevance spans all engineering disciplines, supporting applications in simulation, automation, modeling, and control systems. By laying the groundwork for advanced subjects like data structures, algorithms, and embedded systems, the course prepares students for future academic and professional challenges in an increasingly digital and automated world.

Course Objectives:

1 **To introduce** the fundamentals of programming using C and C++, focusing on syntax, semantics, and program structure for developing simple, efficient solutions.

2 **To develop** the ability to apply control structures, functions, arrays, and strings in solving computational and real-world engineering problems.

3 **To enable** students to understand and implement user-defined data types such as structures, unions, and enumerations for effective data management.

4 **To build** foundational knowledge of pointers, memory management, and file handling to facilitate low-level programming and system-level applications.

5 **To provide** a conceptual and practical understanding of object-oriented programming features in C++, including classes, objects, inheritance, polymorphism, and abstraction.

6 **To prepare** students for advanced computing courses by enhancing their analytical thinking, debugging skills, and ability to write modular, maintainable, and reusable code.

Course Outcomes:

Upon successful completion of the course, the learner will be able to:

1. **Understand and apply** the basic concepts of C programming, including algorithm development, structured programming, data types, operators, control structures, and input/output operations, to develop simple programs.

2. **Apply and analyze** the concepts of functions, arrays, and strings in C to solve computational problems using modular and structured programming techniques.

3. **Apply and analyze** the use of pointers, structures, and file handling techniques to manage memory efficiently and perform structured data operations in C programming.

4. **Understand and apply** the fundamental concepts of object-oriented programming in C++, including classes, objects, encapsulation, constructors, and member functions to design modular programs.

5. **Analyze and apply** advanced object-oriented programming concepts such as polymorphism, inheritance, virtual functions, and abstraction in C++ to develop flexible and reusable software components.

6. **Understand and evaluate** best programming practices, debugging techniques, and industry standards like MISRA guidelines, and **relate** C/C++ programming to real-world applications and emerging technologies.

Detailed Syllabus:

M. No.	Module Name	Detail Topics	Hours	CO Mapping
0	**Prerequisite**	● Basic familiarity with **fundamental mathematical** and **logical reasoning skills**. ● **Understanding of basic computer operations** – such as using a keyboard, mouse, operating systems, and file handling. ● **Logical thinking and problem-solving ability** – including flowcharting, algorithmic thinking, and basic decision-making. ● **Basic English comprehension skills** – to read and write code, understand syntax, and follow programming logic.	**--**	**--**
1	**Fundamentals of C Programming**	● Introduction to Programming, algorithms and Flowcharts ● Program Development Life Cycle (PDLC) - Structure of a C Program, Compilation, Execution ● Concepts of Structured Programming in C ● Data Types, Program Statements, Token, Identifiers, Keywords, Constants, Assignment, Declaration and Initialization, Variables, Operators and Expressions, Lvalue and Rvalues, ● Input/Output Functions, Type Conversion and Typecasting ● Control Structures: if, else, switch-case, loops (for, while, do-while), break, continue, goto	**8**	**CO1**
		Self-Learning Topics: ● Write-up on history and evolution of programming languages ● Practicing Non-Formatted Input & Output functions – getchar( ), putchar( ), getch( ), getche( ), putch( ), gets( ), puts( ) ● Practicing Formatted Input & Output functions – printf( ) - % Format specifiers, formatting the output, escape sequences, Runtime	**8**	

		adjustment and precision – Input Function scanf() – format specifiers, formatted input. ● Preprocessor Directives in C ● Implement pattern generation programs and logic puzzles ● Research: Role of C in Embedded Systems ● Practicing program development logic using Combines Multiple Control Statements: Number guessing game, ATM simulation program, Login system with 3 attempts limit, **Magic** number finder, Menu-driven bank management functions		
2	**Functions, Arrays, and Strings**	● **Functions:** Prototype Declaration, Definition, Function Calling, Passing Parameters to the Function, Scope of Variables, Call by Value. ● **Storage Classes:** auto, static, register, extern ● Recursive Functions, Recursion Vs Iteration ● **Arrays**: 1D, 2D Arrays – Declaration, Initialization, Accessing Array Elements, Operations on Arrays, Applications ● **Strings**: Declaration, Initialization, String Operations, Array of Strings, String manipulation Functions in string.h	**8**	**CO2**
		Self-Learning Topics: ● Sorting an array, Binary searching ● Declaration and Initialization of a Multidimensional Array ● Matrix addition, multiplication ● Arrays of strings: Two-dimensional character array ● Passing Arrays to Functions ● Character manipulation in the String using character functions in <ctype.h> ● Implement recursive solutions (e.g., Fibonacci, Tower of Hanoi) ● Comparison of recursion and iteration (mini presentation)	**8**	

		• Industry application: Use of arrays/strings in data processing		
3	**Pointers, and Structures**	• **Pointers:** Basics, address operator (&), Declaring & initializing Pointer Variables, Indirection Operator and Dereferencing, Pointer Expressions and Pointer Arithmetic, Types of Pointers, Pointer to Pointers, Pointers and Arrays, Call. by value vs Call by address. • **Dynamic Memory Allocation** (malloc, calloc, realloc, free) • **Structures and Unions**, Declaring Structures and Structure Variables, Accessing the members of a structure, Initialization of Structures, typedef, Nested Structures, Arrays of Structures,	**7**	**CO3**
		Self-Learning Topics: • Call by address using pointers, returning more than one value from a function, returning pointer from a function, structures and pointers, passing structure to function • Structure versus Union, Enumeration types • Processing binary files • Write mini programs for file encryption/decryption • Technical write-up: Memory leaks and how to avoid them • Tools: Memory debugging using Valgrind (demonstration/presentation)	**7**	
4	**Introduction to Object-Oriented Programming (C++)**	• Differences between Procedural and Object-Oriented Programming • Introduction to C++, Structure of a C++ Program • Classes and Objects, Standard input and output stream objects, Access Specifiers, Data hiding and Encapsulation, Array of Objects • Constructors and Destructors • Friend Functions, Inline Functions	**7**	**CO4**
		Self-Learning Topics: • Explore syntax differences between C and C++	**7**	

		• Implement class-based programs (Employee Management System, Account Management banking system, Addition of Complex Numbers, student management) • Defining the member functions outside the class • Research: Applications of OOP in industry tools (e.g., game development, simulations)		
5	**Advanced OOP Concepts (C++)**	• **Inheritance:** Creating a Parent-Child relationship between Classes, Types of Inheritance, Implementing Multilevel and Hybrid Inheritance • **Polymorphism:** Introduction of Polymorphism, Types of Polymorphism, **Compile time Polymorphism:** Function overloading, operator overloading, Rules for operator overloading, **Run time polymorphism:** Virtual functions, rules for virtual functions, pure virtual function.	**8**	**CO5**
		Self-Learning Topics: • Working of Constructors with Multiple Inheritance Creating a "String" data type – An example using Operator and function overloading • Create inheritance-based applications (e.g., employee hierarchy system) • Mini project proposal based on OOP concepts • Read and summarize advanced topics like Templates or Exception Handling	**8**	
6	**Industry Applications and Programming Practices**	• Best Practices in Programming: Modularization, Comments, Code Reusability • Debugging Techniques, Error Handling • Applications in Embedded & Real-Time Systems • Introduction to Competitive Programming – Objectives, how it works, Benefits, platforms • Overview of Software Development Life Cycle (SDLC) • MISRA C and MISRA C++ Safe Coding Rules • Role of C/C++ in current technologies (AI, IoT, Game Development, System Software)	**7**	**CO6**

		Self-Learning Topics: ● Research paper or technical write-up on advanced use of C/C++ (e.g., real-time systems, kernel dev) ● Online platform practice (e.g., HackerRank, Codeforces, CodeChef, etc.) ● Seminar/presentation on any emerging tech using C/C++	7	

Text Books

1. "Programming in C", by Pradeep Dey and Manas Ghosh, Oxford University Press.
2. “Object Oriented Programming with C++” by E. Balagurusamy, McGraw Hill Education**.**
3. "Basics of Computer Science", by Behrouz Forouzan, Cengage Learning.
4. "Programming Techniques through C", by M. G. Venkateshmurthy, Pearson Publications.
5. "Programming in ANSI C", by E. Balagurusamy, Tata McGraw-Hill Education.
6. "Let Us C", by Yashavant Kanetkar, BPB Publications.

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2. “Programming: Principles and Practice Using C++” by Bjarne Stroustrup, Addison-Wesley
3. "C Programming: A Modern Approach" by K. N. King, W. W. Norton & Company.
4. "C Primer Plus" by Stephen Prata, Addison-Wesley Professional.
5. "Programming in C" by Stephen G. Kochan, Addison-Wesley Professional

Online Resources:

Sr. No.	Website Name
1	Learn C - This website offers a free, interactive tutorial to learn C programming, covering both basic and advanced topics.
2	Codecademy - Codecademy provides a comprehensive, interactive course for learning C, complete with real-world projects and skill paths.
3	Coursera - Coursera, in collaboration with Duke University, offers a specialization in C programming, including hands-on projects and a certificate upon completion.
4	edX - This course, offered by edX, covers C programming with a focus on Linux, including professional certification.

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14112106	Basics of Semiconductor Physics Lab	--	--	1	--	--	15	--	15	0.5

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical / Oral	Total
		Internal assessment			End Sem. Exam			
		IAT-1	IAT-2	Total				
14112106	Basics of Semiconductor Physics Lab	--	--	--	--	25	-	25

Lab Objectives:

1. To develop scientific understanding of the physics concepts.
2. To develop the ability to explain the processes and applications related to science subjects.
3. To apply skills and knowledge in real life situations.
4. To improve the knowledge about the theory concepts of Physics learned in the class.
5. To improve ability to analyze experimental result and write laboratory report.
6. To develop understanding about inferring and predicting.

Lab Outcomes:

Learners will be able to.

1. Understand the concepts of Hall effect.
2. Experimentally obtain I-V Characteristics of various junction diodes.
3. Experimentally obtain I-V Characteristics of transistors in various configurations.
4. Experimentally obtain I-V Characteristics of FET in configurations

5. Experimentally obtain I-V characteristics of special purpose diodes.
6. Use virtual lab effectively to perform experiments

List of Experiments. (Minimum five experiments required)

Sr No	List of Experiments	Hrs	LO
01	Measurement of Hall Voltage	01	LO1
02	Input – output characteristics of CE configuration	01	LO3
03	Input – output characteristics of CB configuration	01	LO3
04	I-V Characteristics of p-n junction diode	01	LO2
05	I-V Characteristics of Zener diode	01	LO5
06	I-V Characteristics of photo diode	01	LO5
07	Carrier concentration using Hall Effect	01	LO1
08	I-V characteristics of JFET	01	LO4
09	Carrier concentration using Hall Effect	01	LO1
10	Simulation experiments based on nanotechnology using open-source simulation	02	LO6
11	Any other experiment based on syllabus may be included, which would help the learner to understand concept, after defining a suitable LO	02	LO6

Text Books and References:

1. **C.L. Arora**, *B.Sc. Practical Physics*, S. Chand Publications
2. **M.N. Avadhanulu & P.G. Kshirsagar**, *A Textbook of Engineering Physics (Practical)*, S. Chand Publications
3. **A.K. Sawhney**, *Electrical and Electronic Measurements and Instrumentation*, Dhanpat Rai & Co
4. **S. Chattopadhyay, D. Rakshit**, *Practical Physics*, New Central Book Agency
5. **S. Salivahanan**, *Laboratory Manual for Electronic Devices and Circuits*, McGraw Hill Education

Online Resources:

Sr. No.	Website Name
1.	https://mpv-au.vlabs.ac.in/modern-physics/Hall_Effect_Experiment/
2.	https://www.electronics-tutorials.ws/diode/diode_2.html

3.	https://mevlsi-iitkgp.vlabs.ac.in/exp/n-channel-jfet/theory.html
4.	https://www.vlab.co.in/
5.	https://virtual-labs.github.io/exp-hall-effect-nitk/simulation.html
6.	https://www.youtube.com/watch?v=pxdHnXV0kWc

Assessment:

Term Work Marks: 25 Marks (Total marks) = 10 Marks (Experiment) + 10 Marks Project + 5 Marks (Attendance)

Project work: The project is to be completed within one semester. Students must execute the project as per the plan submitted at the beginning of the semester. The project outcome can be a working model, a simulation model, or a study report leading to the anticipated conclusion. Evaluation will be based on the quality of work and adherence to the submitted plan. A proper assessment rubric will be used for awarding marks.

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14122107	Basic Electrical and Electronics Engineering Lab	-	-	2	-	-	30	-	30	1

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT - 1	IAT-2	Total.					
14122107	Basic Electrical and Electronics Engineering Lab	-	-	-	-	-	25	25	50

Pre-requisite: Fundamentals of Physics and Mathematics
Lab Objectives:

Lab course aims to

1. To impart the basic concept of network analysis and its application
2. To provide the basic concept of AC circuit analysis and its application
3. To illustrate the operation of the transformer and machines
4. To demonstrate the behavior and application of special purpose diodes and transistors.
5. To implement and analyze transistor configuration
6. To introduce logic gates

Lab Outcomes:

1. Apply and experimentally verify various network theorems in DC circuits to analyze and simplify electrical networks.
2. Perform experiments on AC circuits to evaluate power factor and analyze phase relationships between voltage and current.
3. Demonstrate transformer operation and identify practical applications
4. Illustrate the performance and applications of motors in automation and peripheral devices.
5. Implement and analyze diode behavior.
6. Demonstrate basic logic gates and implement them using universal gates.

DETAILED SYLLABUS

Sr. No.	List of Experiments	Hours	LO Mapping
Prerequisite	**Fundamental Mathematics and Physics**		
1	Introduction to Laboratory Safety and Usage of Electrical Measuring Instruments	2	LO1
2	Verification of Mesh and Nodal analysis.	2	LO1
3	To verify the equivalence between Star and Delta networks.	2	LO1
4	Verification of DC network Theorems (Superposition. Norton's and Thevenin's)	2	LO1
5	To verify the equivalence of a Voltage Source in series with resistance and a Current Source in parallel.	2	LO1
6	Measurement of electrical parameters for alternating sinusoidal voltage (AC)	2	LO2
7	To calculate and compare Measurement of Active, Reactive and Apparent Power in AC Circuit	2	LO2

8	Observe three-phase voltage relationships in star and delta connections using simulation tools.	2	LO2
9	To simulate and analyze the performance of single-phase transformer	2	LO3
10	Study of DC machines	2	LO4
11	Forward & reverse bias characteristics of PN junction diode	2	LO5
12	Observe LED behavior and test various LED configurations for digital indicators.	2	LO5
13	Construct a BJT-based switch circuit	2	LO5
14	Study of application of Zener diode as Voltage Regulator	2	LO5
15	To simulate the implementation of Basic logic gates using universal gates	2	LO6

Online Resources:

Sr. No.	Website Name
1.	https://www.allaboutcircuits.com/
2.	https://www.tinkercad.com/
3.	https://www.circuitlab.com/

Sr No	List of Assignments / Tutorials	Hrs
1	Application and Analysis of DC Network Theorems: A Study through Theoretical Concepts and Numerical Problems	2
2	Comparative Analysis of DC Network Theorems and Their Extension to Single and Three-Phase AC Circuits: A Theoretical and Numerical Approach	2
3	Theoretical Understanding of Single-Phase Transformers: Principles, Construction, and Role in Modern Power Systems	2

4	Theoretical Insights into Electrical Machines: Working Principles, Construction, and Applications in Modern Industry	2
5	Industrial Applications of Semiconductor Devices: A Study on Diodes and Transistors in Power and Communication Systems	2
6	Design and Application of Basic Digital Circuits: A Study on Logic Gates, Boolean Algebra, and Real-World Implementations	2
7	Case Study 1: Integrated Power System Design: Analysis of DC and AC Circuits with Single-Phase Transformers and Electrical Machines for Smart Residential Applications	2
8	Case study 2: Application of Semiconductor Devices and Digital Electronics in Industrial Automation and Control of Electrical Machines	2

Assessment:

Term Work: Term Work shall consist of at least 8 to 10 practical's based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical& Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14122108	Engineering Graphics & Design Lab	-	-	2	-	-	30	-	30	1

Course Code	Course Name	Theory					Term work	Pract /Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT-1	IAT-2	Total					
14122108	Engineering Graphics & Design Lab	--	--	--	--	--	25	25	50

Lab Objectives:

1 To impart and inculcate proper understanding of the theory of projection.

2 To impart the knowledge to read and interpret a drawing.

3 To improve the visualization skill.

4 To enable students to represent three-dimensional objects on a two-dimensional surface in a way that accurately conveys their shape, size, and orientation.

5 To acquaint students with representing internal features of a three-dimensional object by way of section that accurately conveys their internal orientation.

6 To impart basic AutoCAD skills.

Lab Outcomes:

1	Apply the concepts of Draw, Modify and basic concepts of ACAD to draw basic geometries and diagrams of simple engineering parts.
2	Apply the concepts of layers, and dimensions to create engineering drawing for a part drawing.
3	Create, Annotate, Edit and Plot drawings using basic AutoCAD commands and features.
4	Apply the basic principles of projections in 2D drawings using a CAD software.
5	Apply basic AutoCAD skills to draw different views of a 3D object.
6	Apply basic AutoCAD skills to draw the isometric view from the given two views.

List of Experiments:

Component: 01 – ACAD Print outs (activities to be completed in the CAD Laboratory - All printouts to be the part of Term Work.)

Sr. No.	List of Experiments	Hrs	CO mapping
1	Redrawing simple machine parts as given (05 problems)	04	CO1, CO2, and CO3
2	Orthographic projections (with and without section) (05 problems)	04	CO4 and CO5
3	Isometric Drawing – 3 problems.	04	CO6

Component: 02 – Drawing Sheets

01	Two problems on Engineering Curves	02	CO1
02	Two problems each on Projection of Lines and Planes	02	CO2
03	Two problems on Projection of Solids	02	CO3
04	Two problems on Section of Solids with DLS	02	CO4
05	Two problems each on Orthographic and Sectional Orthographic projection	02	CO5
06	Two problems on Isometric projection	02	CO6

Component: 03 – A3 size Sketch book

Sr No	List of Assignments / Tutorials	Hrs	CO mapping
01	Engineering Curves. (2 problems)	01	CO1
02	Projection of Lines and Planes (2 problems each)	02	CO2
03	Projection of solids. (2 problems)	02	CO3
04	Section of solids (2 problems)	02	CO4
05	Sectional Orthographic and Orthographic Projections (2 problems each)	04	CO5
06	Isometric Drawing. (3 problems)	03	CO6

Assessment:

Term Work: Term Work shall consist of at least 06 practicals based on the above list. Also, Term work Journal must include all the assignments listed above.

Term Work Marks: 25 Marks (Total marks) = 10 Marks (Drawing sheets and ACAD printouts) + 10 Marks (Assignments) + 5 Marks (Attendance)

Practical& Oral Exam: Practical exam on ACAD will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					
		L	T	P	L	T	P	SL	Notional Learning Hour	Total Credits (C) (Notional Learning Hour/30)
14122109	C and C++ Programming Lab	--	--	2	--	--	30	--	30	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT-1	IAT-2	Total				
14122109	C and C++ Programming Lab	--	--	--	--	25	25	50

Lab Objectives:

1. To introduce students to the fundamental programming constructs of C and provide hands-on experience with writing, compiling, debugging, and executing simple programs using an IDE.
2. To enable students to develop modular and efficient C programs by exploring functions, recursion, and arrays, enhancing their understanding of data management.
3. To familiarize students with advanced C programming concepts such as structures, pointers, dynamic memory allocation, for effective data storage and manipulation.
4. To provide comprehensive exposure to object-oriented programming in C++ focusing on classes, objects, constructors, destructors.
5. To deepen understanding of advanced object-oriented concepts in C++ including inheritance, polymorphism, virtual functions, and abstract classes for designing flexible

software solutions.

6. To guide students in designing and implementing an object-oriented system in C++ that integrates key programming concepts for practical application.

Lab Outcomes: At the end of the course, the student will be able to

1. **Analyze and apply** fundamental programming constructs in C using Code::Blocks IDE to develop, compile, debug, and execute programs that implement input/output operations, operators, and control flow structures such as branching, looping, and nested decisions.
2. **Apply and evaluate** the use of functions, recursion, and arrays (including strings) in C programming to design modular and efficient programs that demonstrate data management and manipulation.
3. **Analyze and implement** advanced C programming concepts including structures, pointers with dynamic memory allocation, manage complex data efficiently in real-world applications.
4. **Apply and analyze** core object-oriented programming concepts in C++ including classes, objects, constructors/destructors, and implement polymorphism to develop reusable and efficient code.
5. **Analyze and implement** advanced object-oriented programming concepts in C++ including various inheritance types, virtual functions for runtime polymorphism, and abstract classes with pure virtual functions to create flexible and extensible software designs.
6. **Design, implement, and evaluate** a C++ object-oriented program that models an object-oriented system by applying advanced concepts for efficient data handling and processing.

Suggested list of Experiments:

Sr No	List of Experiments	Hrs.
01	To understand the structure and features of the Code: Blocks Integrated Development Environment (IDE) and to use it effectively for writing, compiling, debugging, and executing C and C++ programs, which will serve as the foundational tool for all further experiments in the lab.	2
02	a) Program to demonstrate operations of Data Input and Output – getchar( ), putchar( ), scanf( ), printf( ), gets( ), puts( ) b) Program to demonstrate Operators-Arithmetic, Relational and logical, Assignment, Unary, Conditional, Bitwise, Comma, other operators.	2
03	Program to demonstrate Branching - If statement, If-else Statement, Multiway decision.	2
04	Program to demonstrate Nested control structure- Switch statement, Continue statement, Break statement, goto statement	2
05	Program to demonstrate Looping – for and nested for loop	2
06	Program to demonstrate Looping – while, do-while	2

07	a) Implement an iterative function for factorial/ Fibonacci etc. b) Implement a recursive function for factorial/ Fibonacci etc.	2
08	Program to demonstrate Array 1D	2
09	Program to demonstrate Array 2D	2
10	Program to demonstrate String and arrays of string.	2
11	Program to demonstrate Structure: Write a program to store and display information of a student/employee etc. using structures a) Define a structure, b) Read and store details, c) Display the stored information.	2
12	Program to demonstrate call by value and call by reference.	2
13	Program to demonstrate the use of classes and objects, constructors and destructors in C++	2
14	Program to demonstrate Single, multilevel, and hybrid inheritance using classes	2
15	Create a system that stores and displays student records including name, roll number, marks for 3 subjects, and computes total marks, average, and grade. Implement the following: 1. A base class Person with attributes: name, roll_no 2. A derived class Student with: Subject marks (e.g., marks[3]) 3. Member functions to input and display data 4. Functions to calculate total, average, and assign grade 5. Use constructors for initialization and destructors to display a message upon object destruction. 6. Use function overloading for displaying summary (e.g., detailed vs short view). 7. Implement operator overloading (e.g., == to compare two students by roll number or marks). 8. Use virtual function in a base class ResultCalculator and override in Student class. 9. Use an array of objects to manage multiple student records.	2

Sr No	List of Assignments / Tutorials	Hrs
01	Flowcharts for programs, input/output operations, operators, and control flow structures such as branching, looping, and nested decisions	2
02	Use of functions, recursion, storage classes, and arrays (including strings) in C programming	2
03	Structures, pointers with dynamic memory allocation, and file handling	2

04	Core object-oriented programming concepts in C++	2
05	Advanced object-oriented programming concepts in C++ including various inheritance types, virtual functions for runtime polymorphism, and abstract classes with pure virtual functions	2
06	C++ object-oriented program that models an object-oriented system by applying advanced concepts for efficient data handling and processing	2

Text Books

1. "Programming in C", by Pradeep Dey and Manas Ghosh, Oxford University Press.
2. “Object Oriented Programming with C++” by E. Balagurusamy, McGraw Hill Education**.**
3. "Basics of Computer Science", by Behrouz Forouzan, Cengage Learning.
4. "Programming Techniques through C", by M. G. Venkateshmurthy, Pearson Publications.
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6. "Let Us C", by Yashavant Kanetkar, BPB Publications.

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4. "C Primer Plus" by Stephen Prata, Addison-Wesley Professional.
5. "Programming in C" by Stephen G. Kochan, Addison-Wesley Professional

Online Resources:

Sr. No.	Website Name
1	Learn C - This website offers a free, interactive tutorial to learn C programming, covering both basic and advanced topics.
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3	Coursera - Coursera, in collaboration with Duke University, offers a specialization in C programming, including hands-on projects and a certificate upon completion.
4	edX - This course, offered by edX, covers C programming with a focus on Linux, including professional certification.

Assessment:

- **Term Work:** Term Work shall consist of at least 10 to 12 practicals' based on the above list. Also, Term work Journal must include at least 2 assignments.

- **Term Work Marks:** 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

- **Practical & Oral Exam:** An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
14122110	IDEA LAB -1 (Innovation Design Engineering and Apply)	**1**	**--**	**2**	**15**	**--**	**30**	**15**	**60**	**2**

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT-1	IAT-2	Total				
14122110	IDEA LAB -1 (Innovation Design Engineering and Apply)	--	--	--	--	**50**	**50**	**100**

Rationale:

Aligned with the National Education Policy (NEP) 2020, the institution emphasizes experiential, interdisciplinary, and project-based learning through the IDEA Lab—a central hub for hands-on innovation.

To strengthen the undergraduate research ecosystem, the institution has adopted a theme-based academic model aligned with UN SGD. Each semester features six curated problem statements based on local need and aligned with core subjects in the same semester, enabling students to apply

classroom knowledge to real-world challenges. Every student selects one problem and develops an individual, subject-integrated solution—enhancing both academic understanding and research skills.

The IDEA Lab supports this initiative with facilities for design thinking, prototyping, and product development. Students maintain a project logbook throughout the semester to track their progress and reflections.

To ensure academic accountability, a two-tier assessment framework is implemented:

- Project Assessment based on standardized IDEA Lab rubrics.
- Subject-Based Term Work Assessment focused on the application of same-semester subject knowledge in the project.

Lab Objectives:

1. To promote experiential and project-based learning that bridges theoretical knowledge with real-world problem-solving.
2. To encourage interdisciplinary integration by enabling students to apply concepts from multiple subjects within a single cohesive project.
3. To develop innovation and design thinking skills through hands-on activities and iterative solution development.
4. To foster critical thinking and creativity by engaging students in open-ended problems with multiple solution pathways.
5. To enhance communication, collaboration, and documentation skills essential for professional engineering practice.
6. To build an entrepreneurial and research mindset by guiding students to develop scalable, socially-relevant, and technically viable prototype

Lab Outcomes: Student will be able to

1. Recall and articulate key concepts from core and allied subjects relevant to the assigned project.
2. Explain the interdisciplinary nature of the problem and the role of each subject in addressing it.
3. Apply appropriate tools, techniques, and theoretical knowledge to develop project components.
4. Analyze problem constraints and user requirements to structure a feasible and efficient solution.

5. Evaluate multiple design options and justify the chosen solution based on technical and practical considerations.
6. Create a functional prototype or solution that demonstrates innovation, utility, and integration of interdisciplinary knowledge

1) Guidelines for IDEA Project

a) Project Guidelines (Interdisciplinary Project Execution in IDEA Lab)

- Each student works on an individual interdisciplinary project aligned with the semester theme.
- Faculty in-charges for the IDEA Lab are assigned according to the complexity of the project and the capacity of the respective departments.
- Faculty in-charges mentor both the academic and technical aspects, and track weekly progress.
- Project assessment will be rubric-based, ensuring depth, innovation, documentation, and ownership.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- Faculty in-charges must attend relevant FDPs to ensure uniformity in mentoring and evaluation.

b) Guidelines for same semester Subject Concepts Applied within the Project

- Term work for each subject will partially reflect how well a student applies subject-specific concepts in their interdisciplinary project.
- Internal assessment panel will collaborate to align project components with subject learning outcomes.

c) Role of Faculty In-Charges in IDEA Lab Projects

Faculty in-charges play a pivotal role in the success of interdisciplinary, theme-based projects under the IDEA Lab. Their responsibilities extend beyond technical supervision to include academic alignment, innovation facilitation, and active student engagement. Their key roles include:

1. **Motivating and Inspiring Students**

- Encourage students to take ownership of their learning and projects.
- Cultivate a mindset of curiosity, exploration, and social relevance.
- Foster an environment where students feel empowered to take creative risks.

2. **Conducting Brainstorming and Ideation Sessions**
   - Organize structured brainstorming sessions at the start of the semester to help students define their problem statements and solution pathways.
   - Promote collaborative thinking, design exploration, and interdisciplinary integration.
3. **Arranging Guest Lectures and Expert Talks**
   - Identify and invite industry experts, researchers, and innovators for guest lectures aligned with the semester's theme or subject areas.
   - Facilitate exposure to real-world challenges, current trends, and future opportunities.
4. **Ensuring Uniqueness and Originality of Projects**
   - Actively review proposed ideas to ensure **no duplication of solutions** across students.
   - Encourage students to explore novel approaches, technologies, and perspectives.
5. **Promoting Discussion and Collaborative Learning**
   - Create platforms for students to present, discuss, and receive peer and mentor feedback.
   - Facilitate idea refinement through regular discussions and group engagement.
6. **Aligning Subject Content Beyond Syllabus**
   - Faculty in-charges must **align subject content beyond the syllabus of the same semester** with the **IDEA Lab theme and assigned problem statements**.
   - This ensures relevance, depth, and meaningful interdisciplinary integration.
7. **Same Semester Faculty Requirement**
   - Faculty in-charges must be teaching subjects in the **same semester** as the students' project to ensure seamless academic integration and contextual understanding.
8. **Monitoring and Documentation**
   - Oversee project logbook maintenance, milestone tracking, and submission of progress reports.
   - Provide ongoing feedback and ensure project alignment with learning outcomes.
9. **Coordination with Subject Faculty**
   - Work in collaboration with other subject faculty to help students embed theoretical and practical aspects of their coursework into the project.
   - Facilitate subject-term mapping and contribute to termwork assessment based on evidence.

2) Implementation Strategy

a) Project Implementation in IDEA Lab

Aspect	Implementation Strategy
Faculty in-charges	**Faculty in-charges assigned based on project nature and department capacity.**
Mentoring Role	**Faculty in-charges oversee academic/technical development, interdisciplinary integration, and timely documentation.**
Capacity Building	**Faculty in-charges undergo workshops on design thinking, innovation, assessment rubrics, and outcome-based mentoring.**
Assessment Contribution	**Faculty in-charges contribute to 25 marks allocated for the IDEA Lab project term work. The remaining assessments are conducted by the external examiner.**
Recognition & Incentives	**Faculty in-charges receive workload credits or are formally acknowledged in performance reviews.**

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b) Implementation of Subject-Term Work Mapping within Projects

Aspect	Implementation Strategy
Mapping Subject Outcomes	**Faculty in-charges align their content beyond syllabus with the student's project by coordinating with the assigned project guide.**
Independent Evaluation	**Internal assessment panel evaluate students based on their application of subject-specific concepts within the project. This contributes to a** separate 25 marks allocated for term work based on subject **application.**
Evidence Sources	**Evaluation is supported by project logbooks, subject-specific deliverables (e.g., tools, simulations, models), and review presentation inputs.**
Outcome Assurance	**Ensures practical demonstration of subject understanding and its integration into the interdisciplinary solution.**

Implementation Notes:

- Guide faculty assess their course's contribution using specific evidence such as:
    - Logbooks

- Subject-specific outputs (e.g., simulations, designs)
- Paper publications or review presentations

2) Guidelines for Assessment

Two-tier rubrics are applied independently to evaluate subject concept application and innovation within the project.

a) Assessment of IDEA Lab Projects (Individual Interdisciplinary Projects) (25 Marks)

Presentation-Based Assessment Structure (Total: 25 Marks)

Assessment Month	Weightage	Marks
Month 1 (Formative 1)	20%	5 marks
Month 2 (Formative 2)	40%	10 marks
Month 3 (Formative 3)	40%	10 marks

Rubric-Based Evaluation Criteria

Criteria	Month 1 (5)	Month 2 (10)	Month 3 (10)
Problem Understanding	Connects problem to subjects	Defines interdisciplinary scope	Demonstrates deep conceptual grasp
Subject Knowledge Application	Identifies relevant concepts	Applies principles in design	Integrates multiple subject areas correctly
Innovation & Design Thinking	Proposes creative idea	Develops and tests feasible solution	Final solution shows originality and utility
Documentation & Presentation	Logbook initiated, plan presented	Mid-design log and visuals	Final report and demo completed
Progress & Ownership	Meets deadlines, shows planning	Demonstrates self-motivation	Completes project independently with reflection

b) Term Work Assessment of Subject Concepts Applied in Projects (25 Marks)

Applicable to All Subjects Integrated with Interdisciplinary Projects

To reflect meaningful application of subject knowledge, each subject will be assessed through the following rubric:

Criteria	**Marks**	**Description**
Subject Knowledge Application	8	Depth and accuracy of concept integration into the project
Practical Design or Tool Usage	5	Use of subject-specific hardware/software/simulation/tools
Documentation	4	Quality and clarity of subject-related logs and reports
Viva/Presentation	4	Ability to explain subject's relevance and role in the project
Continuous Engagement	4	Evidence of consistent participation via logbooks and feedback

c) Total Assessment Structure

Component	Marks	Assessed By
Term work – Project Execution	25 Marks	Project Guide
Term work – Application of Subject Concepts	25 Marks	IDEA Lab Panel
Viva Voce (Final Evaluation)	50 Marks	External Examiner

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					
		L	T	P	L	T	P	SL	Notional Learning Hour	Total Credits (C) (Notional Learning Hour/30)
14412111	Workshop-1	--	--	2	--	--	30	15	45	1.5

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT-1	IAT-2	Total				
14412111	Workshop-1	--	--	--	--	25	—	25

Lab Objectives:

1. To learn the basic concepts in electronic circuits.
2. To learn and perform steps of PCB fabrication.
3. To develop foundational skills in computer hardware assembly.
4. To understand maintenance, troubleshooting, and managing computer networks.
5. To explore and develop proficiency in using Google Workspace tools and to create and publish a functional website using Google Sites.
6. To develop practical skills in using Microsoft Excel and to study and execute AI-powered features in Microsoft Excel.

Lab Outcomes: At the end of the course, the student will be able to

1. Able to understand basic components of electrical components.
2. Able to demonstrate the process of PCB fabrication.
3. Able to assembling and disassembling a personal computer.
4. Able to solve common trouble shooting problem and common hardware issues.
5. Able to navigate and utilize core google workspace and integrate google workspace tools into a google sites.
6. Able to use basic to advance excel function and to use AI-powered features in Excel.

Detailed Syllabus

Sr No	Name of Module	Detailed content	Hours	Lo
1	**Introduction to PCB**	Electronic Components and tools for measuring and debugging electronics circuits. ● Active and Passive components ● Breadboard to built simple circuits. ● Soldering Practices. ● Reading and interpreting circuit diagrams ● Multimeter ● Oscilloscope 8050 and DS0 ● Function generator ● Logic Probe/logic analyzer (demo) PCB Design and fabrication ● Wiring system ● Go-down wiring ● House Wiring ● Staircase wiring ● Introduction To PCB design Software ● Drawing a simple schematic ● PCB layout and routing techniques.	**6** **6**	**LO1, LO2**
		Self- Learning 1. Component Identification and Research (real –life example). 2. Resistor Color Code Practice (learn resistor color code system) 3. Datasheet Study (Download the	**5**	

		datasheet for any 1 component and identify write configuration) 4. Breadboard Familiarization (Watch a tutorial or read a guide on how a breadboard works.)		
2	**Hardware and Networking**	Introduction to Computer Hardware ● Computer Fundamentals Introduction to computers Types of computers Components of computer Input/output devices Storage devices ● Computer Hardware Motherboard architecture Processor types and features RAM types and installation Power supply and units Assembling a computer BIOS/UEFI Configuration Common Troubleshooting issues Installation of LINUX/WIN 11 (DUAL) VM WARE (Installation) Bootable PD (Installation) Google Workspace and Google sites ● Introduction to google Workspace ● Gmail, Email etiquette, labels, filters ● Google Drive: Upload, organize, share ● Google Docs/slides: Collaborate in real time, insert images, comments and tables. ● Google Forms ● Getting Start with Google Sites ● Building basic website ● Creating Multiple pages Microsoft Excel For Engineers and integrate with AI ● Excel interface, data entry, formatting basics ● Formulas and fabrication ● Charts and graphs ● Data sorting and filtering	**6** **4** **4** **4**	**LO3** **LO4** **LO5** **LO6**

		• Getting started with Excel • Data Analysis and visualization • AI in Excel		
		Self-Learning **1.** Study and Report on Motherboard Components and Layout **2.** Create a Maintenance Plan for a Personal Computer **3.** Research BIOS/UEFI Functions and Configuration Options (Provide screenshots and describe real-world use cases. **4.** Design a Small Office/Home Office **5.** Create and Share a Collaborative Google Doc **6.** Organize Files and Folders in Google Drive **7.** Design a Mini-Website for a School Club, Event, or Business Idea	**10**	

Reference Books

1. PCB Design for Beginners by Albert Kelly.
2. Computer Hardware and Networking by Rajiv Chopra.
3. Google Sheets for Beginners: A Practical Guide to Mastering Google Sheets by Nathan George.
4. Google Workspace User Guide by Oliver Kent.

Online Resources

Sr No	Reference
1	https://onlinecourses.swayam2.ac.in/cec25_cs10/preview Computer Fundamentals, By Prof. Sanjay Tanwani.
2	https://onlinecourses.swayam2.ac.in/nou25_cs01/preview -CIT-001: Fundamentals of Computer Systems, By Dr. Mangala Prasad Mishra
3	https://onlinecourses.swayam2.ac.in/aic20_sp59/preview -ESim - EDA tool for circuit design, simulation, analysis and PCB design, By Prof Kannan Moudgalya

4	https://onlinecourses.nptel.ac.in/noc25_ee163/preview -Electronic Systems Design: Hands-on Circuits and PCB Design with CAD, By Prof. Ankur Gupta
5	https://onlinecourses.swayam2.ac.in/imb25_mg206/preview Excel for Finance - From Basics to Advanced, By Dr. Premalatha K P

Suggested list of Experiments:

Sr No	List of Experiments	Hrs.
01	PCB Design and Fabrication.	6
02	Assembling and dissembling of computer. (Demonstration)	2
03	To solve Common Troubleshooting problem solving.	2
04	Installation of LINUX/WIN 11 (DUAL) (Demonstration)	2
05	To create a google form for simple survey or quiz.	2
06	To create grade sheets or expense tracker.	2
07	To build a basic website and make resume and published on site.	2
08	To use excel and ChatGPT/Copilot.	2

Assessment for Term Work (25 marks)

- **Term Work Marks:** 25 Marks (Total marks)
- **Job and Manual**: - 20 Marks
- **Regularity and active involvement: -** 5 Marks

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned					Total Credits (C)
		L	T	P	L	T	P	SL	Notional Learning Hour	(Notional Learning Hour/30
98461112	Universal Human Values	2	-	-	30		-	30	60	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT-1	IAT-2	Total					
98461112	Universal Human Values	-	-	-	-	-	25	-	25

Rationale: The goal of the education system is to cultivate well-rounded individuals who are capable of rational thinking and action, as well as empathy and compassion. It strives to nurture ethical values and principles, shaping responsible citizens who can contribute to creating an inclusive, equitable, and diverse society, as envisioned by our Constitution. Education should focus not only on intellectual growth but also on developing social, ethical, and emotional intelligence. Ultimately, education is essential for unlocking human potential and fostering a just and fair society. A fair combination of holistic and multidisciplinary education would develop human beings wide intellectual, deep aesthetic, social, physical, emotional, and moral in an integrated manner. UHV courses are intended to help students to develop a holistic, humane world vision for adopting fair technological advancements. The modules structured are to be discussed is universal, rational, and verifiable, hence leads to harmony.

Course Objectives:

1. To develop a holistic perspective based on self-exploration about them (human being),

2. To understand the meaning of harmony in relationship family with reverence and compassion

3. To explore a wide range of social networking ensuring mutual happiness and prosperity

4. To identify the urge to establish global peace and harmony to make the world a better place to live.

5. To understand the threats posed by human activities to biodiversity, and provide solutions

6. To develop understanding in implementing technologies to serve mankind.

Course Outcomes:

After successful completion of the course learner will be able:

1. Identify innate humanistic virtues and abilities as fundamentals to work as an individual.

2. Explore solutions to behavioral conflicts through family, a society in miniature with empathy.

3. Develop understanding to maintain human-human relationship for mutual happiness for building great teams.

4. Adapt for global pursuits in a peaceful co-existence with the entire mankind for global society uplift.

5. Acquire awareness of maintenance and conservation of biodiversity to provide sustainable solutions.

6. Evaluate the knowledge of 'Real Self 'augmenting universal human order to develop holistic technologies and creating congenial work environments.

Prerequisite: There is no prerequisite for this course.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	There is no prerequisite for this course.		
I	Holistic Growth of Individual	Understanding the Human Being: Body, mind, and self – their roles and needs, Distinction between the self (conscious entity) and the body, Importance of self-reflection and self-awareness Developing clarity about personal goals and values, Emotional intelligence: managing thoughts and feelings. Lifestyle choices that support well-being Integrating knowledge with ethics and values **Self-Learning Topics**: Analyze yourself thoroughly and discover your personality traits: Behavioral, Habitual and Acquired traits and record the significance of the traits in handling diverse situations in your past and present life.	4 4	CO1
II	Self-Harmony & Family Values	Prosperity - a right identification of needs and fulfillment through right means What is *naturally acceptable* (permanent, universal) vs. what is acquired or conditioned. Family - a space for value cultivation and emotional support, Mutual fulfillment addressing Common Family Issues: Balancing individuality and togetherness, Misunderstandings due to Assumptions, Generational gaps and communication barriers. Trust empathy, and open communication in family relationships. Family as a Basic Unit of Society, Joint versus nuclear family structures and their social impact. **Self-learning Topics**: Importance of Respect and. Compassion in families, relations, neighborhood, how family harmony helps to progress and attain a worthy and respectable social and financial status. Togetherness and advancement, Conflict and resolution	4 4	CO2
		Human-Human relationship, Respecting others and their perspectives, Understanding the difference between *intention* and *competence*. Vision of a		

III	Social Equilibrium	universal human order (Sarvabhauma Vyavastha) based on trust and mutual prosperity. Promotion of dialogue, cooperation, and peaceful coexistence. Individuals and groups work together for common goals and shared well-being. Visualizing a universal harmonious order in society- Undivided Society, Universal Order from self to community Mutual Prosperity. Support and empower marginalized communities **Self-Learning Topic:** A positive and unbiased Mediation and dialogue, and its importance Different communities' views for creating better communities & societies. Incidents happening around you which urgently require social equilibrium as a vision.	5 5	CO3
IV	Shared Values of Mankind	Values accepted and upheld by all human beings regardless of background, peaceful coexistence and global harmony. Role in addressing global challenges like conflict, inequality, and environmental crises, Philosophical and spiritual traditions worldwide. Human rights frameworks (e.g., Universal Declaration of Human Rights). Sensitizing individual towards Contemporary World Issues **Self-Learning Topic:** India's relationships with other countries. Promoting peace and harmony hence preventing conflict situations. Conflict situations throughout the world where India as a one who maintained its integrity by following its traditional, philosophical and ethical standard.	6 6	CO4
IV	Human-Nature Relationship	Humans as caretakers of the Earth, not conquerors. Ethical choices like wildlife conservation, habitat preservation, and reducing pollution. Promoting humane treatment in agriculture, research, entertainment, and daily life. Sustainable living: reducing waste, recycling, and using renewable energy. Educating communities about the importance of biodiversity and ecosystem health. **Self-Learning Topics**: Practices adopted in ancient India for preserving the environment, Importance of rivers, trees, water mentioned in Indian	6	CO5

		scriptures and culture. Modern technologies/practices favoring ecosystem preservation. (Past Practices Vs, Present Practice)	6	
VI	Integrating universal human values in the workplace	Meaningful and Purposeful Work: Encouraging dignity in all types of jobs. Human creativity and contribution to society. Equal opportunities without discrimination. Prioritizing human well-being over mere profit. Technical education is enriched with ethics and human-centric values. Ethical behavior includes not exploiting others for personal gain—whether as employers or consumers. Ability to identify and develop appropriate technologies and management patterns for production systems. Case studies of typical holistic technologies, management models and production systems. **Self-Learning Topics:** Contemporary workplace scenario Confronting challenges like globalization, technological advancement/disruption cultural diversity, workplace prejudice. unconscious bias. Hampering output and how universal human values helps erasing these complexities.	5 5	CO6

References:

1. Gaur, R. R., Sangal, R., & Bagaria, G. P. (2009). *A Foundation Course in Human Values and Professional Ethics*. New Delhi: Excel Books.
2. Ravindran, P. S. (2007). *Essence of Human Values and Professional Ethics*. Chennai: Sri Ramakrishna Math.
3. Gaur, R. R. (2011). *Human Values and Professional Ethics*. New Delhi: Dhanpat Rai Publishing Company.
4. Chitkara, M. G. (2002). *Education and Human Values*. New Delhi: A.P.H. Publishing Corporation.
5. Martin, M. W., & Schinzinger, R. (2005). *Ethics in Engineering* (4th ed.). New York: McGraw-Hill.
6. Gandhi, M. K. (1927). *The Story of My Experiments with Truth*. Ahmedabad: Navajivan Publishing House.
7. Vivekananda, S. (Compilation). (2001). *I and My Nation*. Kolkata: Advaita Ashrama.

8. AICTE (2020). *Towards a Holistic Development: A Collection of Good Practices in UHV*. New Delhi: All India Council for Technical Education.

Online References:

Sr. No.	Website Name
1.	https://uhv.org.in/

Term Work: 25 Marks

Assignments – 20 Marks

Attendance 5 Marks

Conduct Group Speaking Activities to explore and comprehend the basic human and global society issues.

(In group speaking activity, especially, conduct discussions on Contemporary World Issues, Contemporary workplace challenges enabling students to think and suggest solutions on humanitarian ground)

List of Assignments (Answer the questions about in 500 words)

1. Explain the process, content, and natural outcome of self-exploration with a neat diagram and two examples from your life.

2. Analyze the impact of compassion on mental health. Describe the role of family in the development of an individual.

3. Describe the concept of an undivided society and the universal order and explain how both these can help to create a world family.

4. What do we mean by holistic technologies, management models, and production systems? How are these useful for mankind?

5. Explain the concept of co-existence in nature. How can this be understanding help in addressing environmental issues?

6. Design a program to promote respect in the workplace where people treat each other with respect and have equal opportunities for growth.

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
98421113	Enterprise Communication and Corporate Culture	1	-	-	15		-	15	30	1

Course Code	Course Name	Theory					Term Work	Pract /Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT-1	IAT-2	Total					
98421113	Enterprise Communication and Corporate Culture	20	20	40	40	1.5	-	-	80

Rationale:

The course equips electronics and telecom engineers with effective technical and persuasive oral and written proficiencies essential for the environment to create high tech systems and services, Students will learn to decode complex technical ideas and messages, grasp foundational communication models, and develop hands-on expertise in verbal, nonverbal, and digital communication channels. These abilities are vital for professionals to interface with government bodies, private investors, infrastructure partners, and the general public. It helps enhance both a firm's brand identity and its reputation as these interactions are critical for the planning, implementation of various project ideas The curriculum strengthens all four LSRW competencies—Listening, Speaking, Reading, and Writing—to ensure engineers with the proficiency required to convey technical and non-technical information with accuracy, assurance, and professionalism in diverse professional contexts.

Course Objectives - The learners should be able to:

1. Effectively explore the dynamics of communication and navigate professional arenas
2. Competently acquire active listening skills by comprehending physical and digital content
3. Critically analyse communication barriers, audience and purpose to speak proficiently
4. Minutely comprehend extensive texts, technical and non-technical, to execute relevant tasks
5. Efficiently organize and create purposeful technical writing for professional transactions
6. Impactfully relate with other agencies with ethical standards to deliver synergistic solutions.

Course Outcomes - The learners will be able to:

1. Explore and adapt the dynamics of communication to navigate modern professional arenas.
2. Acquire active listening skills by practicing technical and business Speech Acts using direct and digital mode.
3. Analyze barriers, methods, audience and purposes for mastering individual and team speaking in professional & business settings.
4. Synthesize extensive technical and business texts for reflective learning through reading and summarization.
5. Design purposeful and ethical technical and business content, presentation using ICT enabled media.
6. Advocate technical excellence to propagate ethical & sustainable community solutions with a career-oriented approach.

Prerequisite: Basic knowledge of English language

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic knowledge of English language.		

I	Communication Dynamics	Foundations of Communication Dynamics: Objectives Linear vs. Transactional Models, Encoding, Decoding, and Feedback, Interpersonal Communication in Groups: Verbal interaction: Meetings & Presentations, Teleconferences & Calls and Non-Verbal Interactions: Proxemics, Haptics Oculesics, Kinesics Digital Interaction: virtual teams, video calls. Formal and Informal Communication Channels. Barriers: Physical Semantic Psychological & Emotional Barriers, Cultural & Contextual Barriers Silos mentality, Hierarchical layers, Rigid policies, unclear channels, and outdated technology. **Self-Learning Topics**: Communication at Workplace & Outer Agencies Internal communications: Regular email updates, Video conferencing and face to face sessions. External Communication Enterprise Social Media & Networking. Printed and environment Media, Industry collaboration readiness.	5 5	CO1
II	Active Listening	Active Listening: Discussions, and note-taking techniques. Audio-book listening, Understanding colleagues' and clients during meetings. Types of Listening Comprehensive Listening, Critical Listening and Reflective /Empathetic **Self-Learning Topics:** Listening kryptonite: Distractions and Preoccupations Semantic Jargons information overload, speaker pace, Pseudo listening & Interruptions Neglecting Nonverbal Cues, Knowledge Hiding & Siloed Departments	2 2	CO2

III	Conversational Proficiencies	Technical Communication Skills Technical Discussion, delivering technical oral presentations inside and outside organizations Q&A, Explaining Engineering Concepts in Simple Terms (Tips & Guidelines) Grooming and Self Development: **Self-Learning Topics**: Customer pitches and stakeholder meetings. Vendor evaluations or regulatory compliance., vendors as strategic partners, Vendor Negotiations or Demos, Risk & Contingency Planning, Consensus for brainstorm.	2 2	CO3
IV	Text Interpretation Expertise	Intensive Reading, Extensive Reading Skimming, Scanning, SQ5R Method *(Survey, Question, Reading, Recording, Recall, Review and Revise)* Industry Related Articles and Report, Summarizing text to Graphic Organizers (GO) Infographics, Process Flowcharts & Swimlane Diagrams SWOT analysis KWL Charts, Different Types of Organograms etc. Summarizing text in point form. Leveraging Online Resources like IEC standards Market Research Report, Business Case study, Tech Business News, Product Management & Development, Financial & Strategy Reading. **Self-Learning Topics**: Technical Vocabulary, Financial Reports of Electronics Companies' Annual Reports, Supply Chain & Manufacturing:	2 2	CO4
V	Technical & Corporate Writing Skills	Seven Cs of Business Writing Completeness, Conciseness, Consideration, Concreteness, Clarity, Courtesy, Correctness. Format & Types of Formal Letters: Cover Letter, Inquiry Letter Offer Acceptance / Rejection Letter Quotation Letters Grievance Service Change Notification, Recommendation Letter. Technical Writing for Professionals: Short and Long Reports	3	CO5

		Formatting Guidelines Tips for Text Chat user's manuals Standard Operating Procedures (SOP) Product Specification writing. Legal and compliance writing: Compliance Reports and License Agreement. Studio Activities **Self-Learning Topics:** Studio Activities: Content Creation for social media and e-Commerce Platforms Blogs, Vlog Keynote speeches Podcast titles Landing pages social media posts, Shor videos, YouTube video description	3	
VI	Community Communication and Ethics	Communicating clearly with non-technical users and stakeholders Building supportive networks Promoting innovation and problem-solving Participating in user groups or tech meetups Gain encouragement and advice on technical or career challenges. Sustainable smart urban infrastructure, Smart Waste Management Energy Efficiency & Management Communication Transparency and Honesty Accountability Avoiding Misuse of Information Uphold ethical standards in all written, verbal, and digital communication. **Self-Learning Topics:** Ethical use of technology, Sustainable Study Habits: Time Management and Responsibility Active participation in professional communities, forums, and collaborative platforms.	1 1	CO6

References:

1.Communication Skills by Sanjay Kumar & Pushp Lata
2. Business Communication with Writing Improvement Exercises. Hemphill, McCormick &Hemphill
3. Business Communication: Building Critical Skills by Locker, Kitty O. Kaczmarek, Stephen Kyo

4. Effective Business Communication by Herta Murphy
5. Technical Communication: Principles and Practice by Raman and Sharma
6. Effective Technical Communication: A Guide for Scientists and Engineers by Rizvi
7. Oxford Guide to Effective Writing & Speaking by John Seely
8. English Grammar by Raymond Murphy
9. Word Power Made Easy by Norman Lewis

Online References:

Sr. No.	Website Name
1.	https://bbclearningenglish.org
2.	https://www.bbc.co.uk/learningenglish
3.	https://www.anmconsultants.com/role-communication-indian-corporate-culture/
4.	https://venngage.com/blog/white-paper-examples/

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
98422114	Enterprise Communication and Corporate Culture LAB	-	-	2	-	-	30	-	30	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Exam	Total
		Internal assessment			End Sem. Exam			
		IAT-1	IAT-2	Total				
98422114	Enterprise Communication and Corporate Culture LAB	--	--	--	--	25	-	25

Lab Objectives:

The learners should be able to:

1. Effectively explore the dynamics of digital communication in academic and professional arenas.
2. Positively acquire active listening skills through Speech Acts in different modes.
3. Thoroughly analyse communication barriers, audience and purpose to speak effectively at the workplace.
4. Minutely demonstrate technical and non-technical text to comprehend and discern the exact purposes

5. Efficiently organize and create purposeful technical and business writings using ICT enabled media.
6. Successfully manage teams and individual tasks by applying ethical standards to execute the tasks.

Lab Outcomes:

The learners will be able to:
1. Apply communication principles for excellence in academic and professional settings.
2. Test listening capabilities for advanced listening strategies in physical and digital mode.
3. Evaluate and present ideas precisely to the audience in a confident way.
4. Demonstrate reading proficiencies through practicing extensive technical and non-technical texts.
5. Design digital technical and business write ups for professional transactions
6. Implement interpersonal skills and professional ethics to provide fair and collaborative solutions.

DETAILED SYLLABUS

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Basic knowledge of English language and ICT enabled media		
I	Communication Dynamics	Application of Communication Dynamics. Key Components of Strategic Communication, Shannon-Weaver Model at workplace. Enterprise Communication: Industry Reports, and Articles, News Letter, Brand messaging, Multi stakeholders' collaborations. Private - Academic Partnerships	4	LO1
II	Active Listening	Comprehensive Listening and Applications: Technical or Business podcasts, YouTube lecture on academic stuff/ processes/ procedures/		LO2

		Development Plans. Critical Listening: Listen to an audio recording presentation, podcast Interviews and summaries in your words in an oral manner Reflective /Empathetic Listening: Paraphrase What You Hear, Reflect Emotions, Summarize Key Points, Review recorded calls.	4	
III	Conversational Proficiencies	Conversational Activities -I Self Introduction, Prepared Speech on Technical Topics and Impromptu Speech on General Topics Conversational Activities-II Simulation in communication: Role Play Activity for Conflict Resolution Negotiation, Handling complaints or angry customers through simulated phone or chat interactions. Conversational Activities -III customer Communication, Cross-Cultural communication, Marketing & Brand Communication Handling Q&A in Presentation.	8	LO3
IV	Text Interpretation Expertise	Practice Verbal Ability Test (GRE TOEFL and IELTS for grammar and vocabulary Prepare Diagram Organizers on: Summarizing text to Graphic Organizers (GO) Process Flowcharts & Swimlane SWOT analysis KWL Charts, Different Types of Organograms etc.as per the situations in the organizational setting. Summarizing text in point form after reading Market Research Report,	4	LO4

		Business Case study, Tech Business News		
V	Technical and Corporate writing	Technical content: Technical Blog Short and Long Reports (PPT using Canva) Installation Guides Writing Letters and emails, Inquiry Letter Quotation Letters Grievance Service Change Notification Letters Grievance Letter, Letter Standard users manuals Operating Procedures (SOP) Data Privacy Policy, Compliance Reports and License Agreement Content Creation for social media CMS - WordPress to create, manage and publish content. e-Commerce Platforms Blogs, Vlog Podcast titles, Landing pages social media posts	6	LO5
VI	Community Communication and Ethics	Local Area Visit, Field Visits. BSNL, MTNL training Centre Surveys & gaining knowledge on switching mechanism telecom network Feedback Analysis and Report Writing, Providing solutions for technical issues.	4	LO6

Reference Books:

1.Communication Skills by Sanjay Kumar & Pushp Lata
2. Business Communication with Writing Improvement Exercises. Hemphill, McCormick & Hemphill
3. Business Communication: Building Critical Skills by Locker, Kitty O. Kaczmarek, Stephen Kyo
4. Effective Business Communication by Herta Murphy
5. Technical Communication: Principles and Practice by Raman and Sharma
6. Effective Technical Communication: A Guide for Scientists and Engineers by Rizvi
7. Oxford Guide to Effective Writing & Speaking by John Seely
8. English Grammar by Raymond Murphy

9. Word Power Made Easy by Norman Lewis

Online Resources:

Sr. No.	**Website Name**
1.	https://bbclearningenglish.org
2.	https://www.bbc.co.uk/learningenglish
3.	https://www.anmconsultants.com/role-communication-indian-corporate-culture/

List of Experiments.

Sr. No	Name of Experiment	Hours
1.	Prepare a case study on Enterprise Communication strategies/Issues/ Achievements in Select Indian Companies, Tata Consultancy Services (TCS),Infosys,Reliance Jio Infocomm Industries, Bharti Airtel Ltd., Vodafone Idea. BSNL, Tata Communication etc	02
2	Listening Skill Activity Sheet containing minimum three types of listening activities from Lab Syllabus. (Technical Podcasts, Video/Audios of meeting collaboration. Processes and descriptions on You tube channels.	02
3	A.Continuous Evaluation of at least three types of the activities from Lab Syllabus for proficiency in oral communication/presentation	02
4.	a.Two Verbal Ability Test based on GRE, TOEFL, IELTS b. Summary report and Graphic Organizers for the relevant scenario or situation c.Powerpoint / Slide Preparation on business cases studies available online	02
5.	Three Types of Letters Writing in prescribed format (Full Block) along with impressive email messaging Digital Content Creation	02

	from Lab syllabus (Minimum two activities for writing skills should be done with documentation).	
6.	Conduct field visits to small scale business community / Government and non Government Agencies/ ,Metro Projects/ Local visit to MTNL and BSNL/ Traffic Management and ensure the implementation of your subject completely or partially for the smooth functioning of the system Conduct a Survey(Face to face, Kiosk /Mobile , QR Code/ SMS survey and get feedback from outside agencies regarding the future inputs for synergistic solutions.	02

Term Work - 25

Experiments/Practical's -20 marks

10 experiments from all six modules will be conducted using a language lab, open source and must be documented well for final submission as a part of term work at term end.

Attendance -5 Marks

R-2025- F.E Electronics and Telecommunication Engineering

Course Code	Course Name	Teaching Scheme (Contact Hours Per week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14111201	Differential Equations and Integral Calculus	**2**	**1**	**--**	**30**	**15**	**--**	**45**	**90**	**3**

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-1	IAT-2	Total					
14111201	Differential Equations and Integral Calculus	**20**	**20**	**40**	**60**	**2.5**	**25**	**--**	**125**

Rationale:

In a first-year Electronics and Telecommunication Engineering (EXTC) course, foundational mathematical tools are essential for understanding signal behavior, circuit analysis, and system modeling. Higher-order linear differential equations are critical in analyzing RLC circuits, signal transmission lines, and system dynamics where voltage and current vary with time. Double and triple integrals are used in calculating electric field distributions, charge densities, and energy stored in 2D and 3D electromagnetic fields. Vector calculus, involving operations like gradient, divergence, and curl, is fundamental to understanding Maxwell's equations and electromagnetic wave propagation, which are at the core of wireless communication. Complex integration is applied in analyzing sinusoidal signals, resonance, and filter design using contour integration and residue theory. Numerical methods play a crucial role in solving differential equations and large matrix operations that arise in antenna analysis, signal processing algorithms, and circuit simulations where analytical solutions are difficult. These topics not only develop mathematical rigor but also prepare students to tackle practical engineering challenges in electronics, communication systems, and digital signal processing.

R-2025- F.E Electronics and Telecommunication Engineering

Course Objectives:

1. To introduce the application of higher-order differential equations in electrical circuit modeling and system analysis.
2. To explain the use of double integrals for calculating surface area and charge density in electronic components.
3. To demonstrate the use of triple integrals for volume and energy calculations in 3D fields.
4. To introduce vector operations for understanding electromagnetic field behavior and Maxwell's equations.
5. To teach complex integration techniques relevant to signal analysis and circuit theory.
6. To present numerical techniques for solving mathematical models in signal processing and circuit design.

Course Outcomes:

1. Students will be able to solve and analyze using SCILAB RLC circuits and communication systems modeled by differential equations.
2. Students will evaluate double integrals and use SCILAB to compute quantities such as capacitance or energy in 2D regions.
3. Students will apply triple integrals and use SCILAB to determine volume charge distributions and electromagnetic field energy.
4. Students will analyze electric and magnetic fields using gradient, divergence, and curl operations.
5. Students will solve problems in signal processing and interpret filter behavior using residue and contour integration.
6. Students will use numerical methods and SCILAB to approximate solutions for systems such as differential equations in filters or transmission lines.

Prerequisite:

1. Basics of integration and it's properties**.**

2**.** Linear differential equations

DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	Differential Equation	Exact differential Equations, Equations reducible to exact form by using integrating factors.	05	CO1
		Equation reducible to linear form, Bernoulli's equation.		
		Linear Differential Equation with constant coefficient-complementary function, particular integrals of differential equation of the type f(D)y = X where X is e^{ax} , sin(ax + b), cos(ax +b), x^m.		
		Self-learning topics: 1. Method of variation of parameter 2. Particular integrals for $e^{ax}V$ and xV. 3. Cauchy's homogeneous linear differential equation. 4. Legendre's differential equation. 5. Applications of first order and first degree and also Higher order differential equation.	08	
II	Multiple Integral-I	Beta and Gamma functions and its properties.	05	CO2
		Double integration-definition, Evaluation of Double Integrals. (Cartesian & Polar)		
		Change the order of integration (No Evaluation)		
		Self-learning topics:	07	

		1. Rectification of curves. (Cartesian, Polar and Parametric) 2. Application of double integrals to compute Area and Mass of lamina.		
III	Multiple Integral-II	Evaluation of double integrals by changing to polar coordinates	O5	CO3
		Evaluation of integrals over the given region (Cartesian and polar).		
		Triple integration definition and evaluation (Cartesian, cylindrical and spherical polar coordinates).		
		Self-learning topics: 1. Application of triple integrals to compute volume. 2. Triple integrals over a volume bounded by a plane. 3. Triple integrals over a volume bounded by a paraboloid. 4. Triple integrals over a volume bounded by a cone. 5. Triple integrals over a volume bounded by an ellipsoid.	07	
IV	Vector Calculus	Scalar and vector fields. Differentiation of vectors	05	CO4
		Directional derivative, Gradient, divergence and curl		
		Scalar potential function		
		Self-learning topics: 1. Line integrals – definition and problems. 2. Green's theorem in a plane, 3. Stokes' theorem (without Proof) 4. Gauss' Divergence theorem (without proof) and problems (only evaluation). 5. Angle between surfaces.	07	
V		Cauchy's Integral theorem and formula,	05	CO5

	Complex Integration	Taylor's series and Laurent's series - radius of convergence		
		Singularities and Poles, Cauchy Residue theorem.		
		Self-learning topics: 1. Line Integral in cartesian and parametric form. 2. Application of Residue Theorem to evaluate real integrations. 3. Conformal Mappings.	08	
VI	Numerical Methods	Numerical integration-by (a) Trapezoidal (b) Simpson's 1/3rd (c) Simpson's 3/8th rule (all without proof)	05	CO6
		Interpolation by Newton's and Lagrange polynomials		
		Numerical solutions of transcendental equations by Newton Raphson method and Regula –Falsi method.		
		Self-learning topics: 1. Indeterminate forms, L- Hospital Rule, 2. Gauss Elimination Method, Gauss Jordan Method. 3. Maclaurin Series 4. Numerical solution of ordinary differential equation using (a) Euler's method (b) Modified Euler method, (c) Runge-Kutta fourth order method	08	

Text Books:

1. Grewal B. S.: "Higher Engineering Mathematics", Khanna Publishers, 44th Ed., 2021.

2. Kreyszig E.: "Advanced Engineering Mathematics", John Wiley & Sons, 10th Ed., 2018.

3. Dass H. K.: "Higher Engineering Mathematics", S Chand & Company Ltd, 12th Ed., 2004.

4. Narayan S.: "Differential Calculus", S.Chand Publications, 30th Ed., 2005.

References:

1. Stewart J.: "Multivariable Calculus" Cengage Publications, 7th Ed., 2019.
2. Jain M.K., Iyengar SRK, Jain R K,: "Numerical Methods for Scientific and Engineering Computation", New Age International Publishers, 6th Ed., 2007.
3. Bali N.P and Goyal M.: "A Textbook of Engineering Mathematics" Laxmi Publications, 10th Ed., 2022.
4. Wylie C. R, Barrett L.C..: "Advanced Engineering Mathematics" McGraw Hill Book Co., New York, 6th Ed., 2017.
5. Ramana B.V.: "Higher Engineering Mathematics", Tata McGraw-Hill Publishing Company Limited, 1st Ed., 2006.
6. Gupta C.B, Sing S.R and Mukesh Kumar: "Engineering Mathematic for Semester I and II", Mc-Graw Hill Education, 2015.
7. Pal S. & Bhunia S. C.: "Engineering Mathematics" Oxford University Press, 3rd Ed., 2016

Online References:

Sr. No.	Website Name
1.	https://archive.nptel.ac.in/courses/111/105/111105122/
2.	https://www.youtube.com/watch?v=T6jHXD78dBI
3.	https://www.youtube.com/watch?v=KgItZSst2sU
4.	https://www.youtube.com/watch?v=w_KiHgultbM

Assessment:

Term work(TW) for 25 marks:

1. Batch-wise tutorials are to be conducted.

2. Students must be encouraged to write SCILAB Programs in tutorial class only. Each Student has to write **at least 05 SCILAB tutorials** (including print out) and **at least 10** class tutorials on entire syllabus.

3. SCILAB Tutorials will be based on entire syllabus.

The distribution of Term Work marks will be as follows –

1. Regularity and active involvement (Theory and Tutorial) 05 marks

2. Class Tutorials on entire syllabus 10 marks

3. SCILAB Tutorials 10 marks

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C)
		L	T	P	L	T	P	SL	Notional Learning Hour	(Notional Learning Hour/30)
14111202	Engineering Chemistry for electronics components and materials	2	--	--	30	--	--	30	60	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs.)			
		IAT-1	IAT-2	Total					
14111202	Engineering Chemistry for electronics components and materials	20	20	40	60	2.5	--	--	100

Rationale:

1. Chemical science has contributed in many ways to most of the Engineering branches where "Applied Chemistry" is the modern approach to learn impact of Technology on habitat and can be common to all Core Groups,
2. "Engineering Materials" can be prerequisites to impact of corrosion on metals as many civil engineering materials is the important area of concern.
3. "Advanced polymers and ceramics" are the matter of general approach to all but especially to electronics group as an emerging development in this sector
4. Chemical science has contributed in many ways to most of the Engineering branches where "Applied Chemistry" such as water, polymers, corrosion, electro chemistry, alloys and ceramics, can be prerequisites to many subjects of all core groups from the perspective of applications as a build material for structural as well as maintenance component in electronics.

Course Objectives:

1. To study effect of hardness of water on various materials used in electronics.
2. To introduce important properties of polymers as Engineering material.
3. To study the effect of corrosion by different mechanisms on metals and methods of corrosion control
4. To study electrochemistry for give a general idea on various basic theories in used in electronics.
5. To recognize importance of alloys and can apply the phase rule on it to study the effect of temperature and composition
6. To study the ceramics as an important part as a structural component used in electronics.

Course Outcomes: Student will be able to –

1. determine the hardness of water and various method of water hardness removal.
2. use the polymers for specific engineering applications on the basis of the properties.
3. understand the causes of corrosion and apply different methods to minimize corrosion.
4. determine the electrochemical reactions and their impact.
5. understand the various alloys and to Interpret various phase transformations of alloy using thermodynamics.
6. Understand the role, purpose and use of ceramics as a structural component used in electronics.

Prerequisite: (For Theory **Course**)

1. Knowledge about basic concept of hardness of water.
2. Knowledge of basic properties of polymers.
3. Knowledge of basic concept of electrochemistry and corrosion mechanism.
4. Knowledge of concepts of nanomaterial.
5. Knowledge of basic difference of ferrous and nonferrous alloys.
6. Knowledge of constituents of materials used in electronics equipment.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Knowledge about basic concept of hardness of water, properties of polymers, concepts of Electrochemistry and corrosion mechanism, nanomaterials and its application, properties of metals and nonmetals and purpose of making alloys, Constituents of materials used in electronics equipment.		
I	Water	1. Impurities in water, Hardness of water 2. Determination of hardness of water by EDTA method and numerical problems, 3. softening method of water and numerical based on it –i) Ion exchange process ii) electro dialysis iii) reverse osmosis iv) ultrafiltration. 4. Definition, significance and numerical problems based on BOD and COD.	05	CO1

		Self-learning Topics: **1.** Industrial water treatment in semiconductor manufacturing. **2.** Environmental impact of electronic industry wastewater. **3.** Water purification technologies in PCB fabrication. **4.** BOD & COD monitoring in electronics waste management. **5.** Innovations in reverse osmosis and nano-filtration systems.	05	
II	Advanced polymers.	**1.** Macro-molecular science, i) basic concept of polymers, ii) Chemical bonding in polymers, iii) Classification of Polymers. **2.** Properties of Polymers: - i) Molecular weight - Number average molecular weight, Weight average molecular weight, Numerical, ii) Crystallinity - Crystalline and amorphous polymers – Glass transition temperature. **3.** Advanced polymers: i) Conducting polymers: ICP, DCP, ECP, Coordination conducting polymers, ii) Application of conducting polymers.	05	CO2
		Self-learning Topics: **1.** Conducting polymers in flexible electronics	05	

		2. Application of intrinsically conductive polymers (ICPs) in sensors and OLEDs. **3.** Biodegradable polymers in electronic packaging **4.** Glass transition temperature and its role in 3D printing of electronic devices **5.** Polymer nanocomposites in EMI shielding.		
III	Corrosion	**1.** Introduction: Definition, Types of Corrosion – i) Dry or Atmospheric Corrosion, ii) Wet or Electrochemical corrosion (In Acidic medium, In Neutral medium) **2.** Factors affecting rate of corrosion: i) Position of metal in galvanic series, ii) Purity of Metal, iii) Nature of Corrosion product, iv) Temperature, v) pH of medium, vi) concentration of medium, vii) moisture, viii) Relative Cathodic and Anodic area, ix) overvoltage **3.** Methods to control corrosion: i) Selection of metal, ii) Proper Designing, iii) Cathodic protection, iv) Use of Corrosion Inhibitors, v) Metallic Coating- metal cladding, galvanization, tinning, metal spraying	05	CO3
		Self-learning Topics: **1.** Corrosion issues in microelectronics and circuit boards	05	

		2. Corrosion protection in wearable electronics. **3.** Nano coatings and corrosion-resistant materials in sensors. **4.** Electrochemical corrosion testing techniques. **5.** Corrosion in lithium-ion batteries.		
IV	Important Engineering materials: Nano materials:	**1.** Nano materials: fullerene – properties and uses **2.** carbon nano tubes- properties, method of preparation. **3.** applications of CNTs	04	CO4
		Self-learning Topics: **1.** Applications of carbon nanotubes in VLSI and NEMS/MEMS. **2.** Fullerene-based drug delivery and biosensors. **3.** Synthesis methods for nanomaterials (sol-gel, hydrothermal). **4.** Toxicological impact of nanomaterials in electronics. **5.** Graphene in transparent electronics and photonics.	04	
V	Alloys	Alloys: **1.** Ferrous alloys – i) Plain-carbon steels ii) Heat and Shock resisting steels iii) Stainless steels iv) Effect of the alloying element- Ni, Cr, Co, Mn, Mo, W and V. **2.** Non-Ferrous alloys: A) Aluminum alloys – Composition, properties and uses of i) Duralumin, ii) Magnalium	06	CO5

		B) Copper alloys – Composition, properties and uses of a) Brass – i) Dutch Metal ii) German Silver b) Bronze – i) Gun metal ii) Nickel bronze. C) Alloys of Pb – Composition, properties and Uses of i) Wood's metal ii) Tinman's solder. **3.** Numerical: i) based on Composition, ii) based on density iii) based on weight of an alloy. **4.** Smart alloys: Types, composition and application of smart alloys in electronics		
		Self-learning Topics: **1.** Smart alloys in actuators and MEMS devices. **2.** Ferrous vs. non-ferrous alloys in electronics heat sinks. **3.** Solder alloys in surface mount technology (SMT). **4.** Effect of alloying elements on electrical conductivity. **5.** Shape memory alloys in micro positioning systems.	06	
VI	Important Electronics Engineering materials	**1.** Introduction, **2.** Materials required in electronics component: i) Silicon and related materials, **ii)** Germanium and related materials, iii) Gallium compounds, iv) Carbon based materials, v) Conductive and insulating materials, vi) Magnetic materials	05	CO6

		3. Etching materials: i) Hydrofluoric acid ii) Phosphoric acid, iii) Chlorine and fluorine-based gases.		
		Self-learning Topics: **1.** Silicon purification process in IC fabrication. **2.** Gallium arsenide and its use in RF and microwave devices. **3.** Germanium-based materials for IR detection. **4.** Magnetic materials in transformers and storage devices. **5.** Etching gases and safety protocols in cleanrooms.	05	

References:

1. Engineering Chemistry, Jain and Jain, Dhanpat Rai Publication
2. A textbook of Engineering Chemistry, S. S. Dara, S. Chand and Company
3. Polymer science: Vasant Gowarikar, Wiley Estern Ltd, new Delhi
4. Green Chemistry: V. K. Ahluwalia
5. Textbook of Polymer science: F.W. Billmeyer
6. Fundamentals of Polymer science & Engineering- Anilkumar & S K Gupta, Tata McGraw Hill, New Delhi
7. Engineering Chemistry, O. G. Palana, Tata McGraw Hill Publication
8. Environmental Chemistry, A. K. De, Tenth edition, New Age International,
9. P. W. Atkins, Physical Chemistry, Oxford University Press, 7th edition. 5. J. D. Lee Concise Inorganic Chemistry, Oxford University Press, 5 th edition

Online References:

Sr. No.	Website Name
1.	https://archive.nptel.ac.in/courses/103/106/105106205/
2.	https://courses.nptel.ac.in/noc20ch41/preview
3.	https://www.researchgate.net/
4.	https://www.sciencedirect.com/topics/engineering/polymer-material
5..	https://www.sciencedirect.com/topics/chemistry/nanomaterial

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14121203	Engineering Mechanics	2	-	-	30	-	-	-	60	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT -1	IAT -2	Total					
14121203	Engineering Mechanics	20	20	40	60	2.5	--	--	100

Rationale:

Engineering mechanics is a branch of science that deals with the behaviour of solid bodies when subjected to external forces or loads and the effects of these forces on the bodies. Engineering Mechanics plays a vital role for students of Electronics - Telecommunication and Computer Science - Engineering by bridging the gap between software, electronics, and the physical world. It supports the understanding of mechanical behaviour in electromechanical systems such as sensors, actuators, antennas, and robotic communication systems. With the growing integration of IoT, embedded systems, and cyber-physical technologies, a solid grasp of mechanics is essential for designing reliable, efficient, and physically robust systems. The subject contributes to vibration analysis, structural hardware design, and the simulation of physical behaviours, enabling students to develop smart, adaptive systems in advanced applications like automation, control systems, AR/VR, and digital twins.

Course Objectives

1 To acquaint with basic principles of Centroid and its real-life significance
2 To familiarize with the concepts of force, moment, couple, resultant and system of coplanar and non-coplanar forces.

3	To familiarize with the concepts loads, beams, equilibrium conditions, friction and their real-life applications.
4	To understand the motion parameters required for quantification of Kinematics of Particle and Rigid body.
5	To understand the combination of force and motion parameters required for quantification of Kinetics of rigid body.
6	To acquaint with the basics of Robot kinematics

Course Outcomes

1	Demonstrate the understanding of Centroid and MI and locate the same.
2	Determine the resultant and equivalent force-couple system for a given system of forces.
3	Illustrate the concept of loads, supports, beams, conditions of equilibrium, and friction and apply the same in two dimensional systems with the help of FBD.
4	Determine the position, velocity, and acceleration of particle and rigid body using principles of kinematics for rectilinear, curvilinear and general plane motion.
5	Apply the principles of force and acceleration, work-energy and impulse-momentum to particles in motion.
6	Establish the relation between robot joints and parameters

Prerequisite: Student shall have passed HSC (Higher Secondary Certificate) along with basic understanding of physics and mathematics in following topics:-

1. **Basic Vector Algebra**
   – Understanding of vector addition, subtraction, scalar and vector products.
   – Ability to resolve vectors into components.
2. **Fundamentals of Classical Physics**
   – Concepts of force, motion, Newton's laws, equilibrium, and gravity.
   – Understanding of mass, weight, friction, and types of motion.
3. **Basic Trigonometry and Geometry**
   – Familiarity with sine, cosine, tangent functions.
   – Knowledge of angles, triangles, and coordinate systems.
4. **Problem-Solving and Logical Reasoning Skills**
   – Ability to approach real-world physical problems logically.
   – Basic analytical thinking and spatial reasoning.

Detailed Syllabus

Module no.	Module Name	Detailed content	Teaching hours	CO
0	**Prerequisite**	Statics, Dynamics, Kinetics, Kinematics, Rigid body, Deformable body, applying trigonometric functions, resolution of a vector (Force vector), Law of triangle, Polygon law of forces, Newton's laws of motion	01	

		Velocity, acceleration, displacement, Uniform velocity and accelerated motion, Law of conservation of Energy, Law of conservation of Momentum, work-energy principle, impulse and momentum principle, and Co-efficient of restitution		
1	**Centroid**	i. Characteristics, and real-life significance for Centroid ii. Centroids of primary geometrical shapes and plane laminas **Self-learning topic:** - Centroid for area with sector and real-life application - Exploring Moment of Inertia for primary geometrical shapes and plane laminas	03 03	CO 1
2	**Force and System of Forces**	i. Principle of transmissibility, Moment of force about a point and concept of couple ii. Classification of force systems iii. Resultant of coplanar system of forces and Varignon's Theorem iv. Resultant of non-coplanar system of forces **Self-learning topic:** - Exploring force and a couple system and real-life application of a force and a couple system - Resultant of non-coplanar parallel and general system of forces	05 05	CO 2
3	**Equilibrium and Friction**	i. Conditions of equilibrium for system of forces and free body diagrams, Types of beams, loads, and support and its reaction ii. Equilibrium of beams, rollers, and system of bodies iii. Laws of friction. Cone of friction. angle of repose, and angle of friction iv. Application of equilibrium with friction on blocks on horizontal and inclined planes and ladders **Self-learning topic:**	07	CO 3

		- Equilibrium of connected bodies (beam and sphere), two force and three force members, beams connected using internal hinges - Application of equilibrium with friction - Wedge and block	07	
4	**Kinematics of particles and rigid bodies**	i. Motion along plane curved path, Variable acceleration for rectilinear motion, projectile motion ii. Introduction to General plane motion, problem based on Instantaneous centre (ICR) method for general plane motion (up to 2 linkage mechanism and roller) **Self-learning topic:** - Application of motion graph for real-life problems - ICR for rollers, wheels and three links problems - ICR for system of rigid bodies	06 06	CO 4
5	**Kinetics of particles**	i. Introduction to D'Alembert's Principle (DAP), inertia force, dynamic equilibrium, Work done by active forces, impact and collision ii. Problems on DAP (single and double block), and WEP (single block) **Self-learning topic:** - Application of WEP to the real-life problems - Explore the concept of impact and collision for rigid bodies	04 04	CO 5
6	**Introduction to Robot Kinematics**	i. Fundamental of Robot Mechanics, Degree of Freedom, D-H Parameters, robot kinematics (Forward) ii. Homogeneous transformation (limited to 2 DOF Serial robot) **Self-learning topic:** - Derive and Analyze - Manual derivation of forward kinematics using D-H parameters	04 04	CO 6

		- Explore online simulation tools such as MATLAB Robotics Toolbox Online and refer https://kinematicsplayground.org/ - Solve 2 numerical problems involving: Assigning D-H parameters and finding of end-effector pose using transformation matrices		

Text Books:

1. Engineering Mechanics by A K Tayal, Umesh Publication.
2. Engineering Mechanics by Kumar, Tata McGraw Hill
3. Engineering Mechanics by Beer &Johnston, Tata McGraw Hill

References:

1. Engineering Mechanics by R. C. Hibbeler.
2. Engineering Mechanics by F. L. Singer, Harper& Raw Publication
3. Engineering Mechanics by Macklin & Nelson, Tata McGraw Hill

Online References:

Sr. No.	Website Name
1	https://archive.nptel.ac.in/courses/112/106/112106286/
2	https://archive.nptel.ac.in/courses/112/106/112106180/

R-2025- F.E Electronics and Telecommunication Engineering

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14211204	Elements of Telecommunication	3	--		45	--	–	45	90	3

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical / Oral	Total
		Internal assessment			End Sem. Exam	Exam Duration (in Hrs)			
		IAT-1	IAT-2	Total					
14211204	Elements of Telecommunication	20	20	40	60	2.5	–	–	100

Rationale:

This course introduces students to the fundamental principles of communication systems, including analog, digital, mobile, optical, satellite, and computer networks. It builds a foundational understanding essential for advanced studies and applications in modern Electronics and Telecommunication Engineering.

Course Objectives:

1 Understand the fundamental principles and components of analog communication systems, including modulation and demodulation techniques.
2 Comprehend digital communication techniques such as PCM and digital modulation schemes, and their advantages in modern systems.
3 Gain insights into computer communication networks, including topologies, protocols, transmission media, and switching.
4 Explore the architecture and evolution of mobile and wireless communication systems, including emerging 5G and IoT technologies.
5 Understand the basic principles, structure, and applications of fiber optic communication systems.
6 Learn the essential concepts of satellite communication, including orbits, subsystems, frequency bands, and real-world applications.

Course Outcomes:

1. Describe the basic structure and working of analog communication systems and compare AM and FM techniques. *(Understand)*
2. Explain the principles of digital communication systems and analyze digital modulation techniques like ASK, FSK, and PSK. *(Understand, Analyze)*
3. Identify the fundamental components of computer communication networks and differentiate between topologies and transmission methods. *(Understand)*
4. Illustrate the working of mobile communication systems and recognize the features of 1G to 5G, Wi-Fi, Bluetooth, and IoT protocols. *(Understand, Apply)*
5. Demonstrate an understanding of fiber optic communication systems, including components, propagation mechanisms, and applications. *(Understand, Apply)*
6. Explain satellite communication fundamentals, including orbits, subsystems, frequency bands, and their role in global connectivity. *(Understand)*

Prerequisite: Physics , Mathematics

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic understanding of physics concepts such as **waves, frequency, electromagnetic spectrum**, and **electrical fundamentals** (voltage, current, resistance). Familiarity with **mathematical concepts** like **trigonometry and basic calculus** is helpful for analyzing signals and communication systems.		
I	Fundamentals of Analog Communication	Introduction to Communication Systems: Elements, Types (Analog, Digital), Need for Communication Characteristics of Signals: Analog vs. Digital, Frequency Spectrum, Need for Modulation, Amplitude Modulation (AM): Principle, Generation, Demodulation, Applications Frequency Modulation (FM): Principle, Generation, Demodulation, Applications Comparative Study of AM, FM Self-Learning Topic: Applications of Modulation in Broadcasting and Aviation Communication, Explore how AM and FM are used in practical systems like radio, aircraft communication, and two-way radios	7 7	CO1

II	Principles of Digital Communication	Basics of Digital Communication: Benefits, Noise Immunity, Multiplexing, Sampling Theorem and Aliasing, Quantization and Encoding, Pulse Code Modulation (PCM): Block Diagram, Advantages, Applications, Digital Modulation Techniques: Basics of ASK, FSK, PSK with Waveform Diagrams and Applications, Introduction to Bit Error Rate (BER) and Bandwidth Efficiency Self-Learning Topic: Role of Error Detection and Correction Techniques in Digital Communication, Understand the basics of parity checks, Hamming codes, and CRCs in reliable data transfer.	8 8	CO2
III	Computer and Data Communication Networks	Introduction to Computer Networks and Network Classifications: PAN, LAN, MAN, WAN, Network Topologies: Features and Use Cases, ISO-OSI and TCP/IP Protocol Stack – Role of Each Layer, Transmission Media, Data Communication Basics: Serial and Parallel Transmission, Synchronous and Asynchronous, Introduction to Switching Techniques: Circuit, Packet, and Message Switching Self-Learning Topic: Wireshark Basics: Capturing and Analyzing Network Packets-Learn how to inspect real-time data packets to understand TCP/IP protocol behavior using a free tool	7 7	CO3

IV	Mobile and Wireless Communication Systems	Basic Concepts: Cell, Frequency Reuse, Handoff, Roaming, Evolution of Mobile Communication: 1G to 5G, Mobile Operating Systems and Platforms (Android, iOS basics), Introduction to Wi-Fi (IEEE 802.11), Bluetooth, and IoT Communication Protocols (Zigbee, LoRa), Application Areas: Mobile broadband, smart cities, mobile health Self-Learning Topic: Evolution and Applications of 5G Technology- Study the architecture and key features of 5G and how it impacts IoT, autonomous vehicles, and smart cities.	8 8	CO4
V	Fiber Optic Communication and Photonics Applications	Review of Light Propagation Principles: Reflection, Refraction, Dispersion, Structure and Types of Optical Fibers (SMF, MMF), Optical Sources and Detectors (LED, Laser Diodes, Photodiodes), Optical Communication Link: Transmitter, Channel, Receiver, Modern Applications: FTTH (Fiber to the Home), Optical Sensors, Smart Grid, Medical Imaging, Challenges: Losses, Bending, Attenuation Self-Learning Topic: Use of Optical Fibers in Biomedical Imaging (Endoscopy, OCT)-Investigate how fiber optics enables non-invasive diagnostics in medical fields.	8 8	CO5

VI	Satellite and Space Communication	Introduction to Satellite Communication and Orbits (LEO, MEO, GEO), Satellite Subsystems: Payload, Power, Attitude Control, Telemetry, Frequency Bands: C, Ku, Ka – Use Cases and Limitations, VSAT and DTH Systems: Architecture and Operation, GNSS (GPS, GLONASS, IRNSS/NavIC): Principles and Applications, Emerging Trends: CubeSats, Starlink, Satellite-IoT Convergence Self-Learning Topic: LEO Satellite Constellations and Internet Services (e.g., Starlink)-Learn how Low Earth Orbit satellites are transforming global broadband access.	7 7	CO6

Text Books:

1. "Electronics Communications System" by George Kennedy.
2. “Optical Fiber Communications” by Gerd Keiser, 5th Edition
3. "Data Communications and Networking" by Behrouz A. Forouzan, Fifth Edition TMH, 2013.
4. T. Pratt, C. Bostian, and J. Allnutt, Satellite Communications, 2nd ed., Wiley, 2002.

References:

1. Simon Haykin, “Communication Systems”, 4th Edition, John Wiley & Sons, 2004.
2. Optical Fiber Communication: Principles and Practice, John M. Senior, 3rd edition.
3. M. Richharia and L. K. T. S. Mhurchu, Satellite Communications Systems: Systems, Techniques and Technology, 6th ed., Wiley, 2020.

Online References:

Sr. No.	Website Name
1.	Analog Communication By Prof. Goutam Das (IIT Kharagpur); https://swayam.gov.in/nd1_noc20_ee69/preview
2.	https://nptel.ac.in/courses/108/101/108101113/
3.	https://nptel.ac.in/courses/117/101/117101050/
4	http://nptel.ac.in/courses/117104099/ - (Advanced 3G and 4G Wireless Mobile communications)
5	https://www.iitg.ac.in/psm/qip2015/material/Subir_Bandyopadhyay_Lecture1.pdf
6	https://archive.nptel.ac.in/courses/117/105/117105131/

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
14112205	Engineering Chemistry for electronics components and materials Lab	--	--	1	--	--	15	--	15	0.5

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT-1	IAT-2	Total.					
14112205	Engineering Chemistry for electronics components and materials Lab	-	-	-	-	-	25	--	25

Lab Objectives:

1. To apply knowledge acquired during the theory class in carrying out the experiments for qualitative and quantitative determination.
2. To analyze experimental results and write laboratory report.

Lab Outcomes: After completion of experiment, the learners will be able to

1. Estimate the type of water hardness and calculate it.
2. Synthesize UF/PF resin at laboratory level.
3. Learn the effect of various factors on the rate of corrosion.
4. Understand the significance of electrochemistry principles
5. Learn various volumetric quantitative analytical techniques to determine % of elements from alloy samples and concept of smart alloys used in electronics
6. Learn various instrumental quantitative analytical techniques to determine % of elements from alloy samples and concept of smart alloys used in electronics.

List of Experiments:

Sr No	List of Experiments	Hrs
01	Determination of Total, Temporary and Permanent hardness of water by EDTA method	**01**
02	Estimation of chloride content in the given water sample.	**01**
03	Synthesis of Urea formaldehyde Resin.	**01**
04	Synthesis of Phenol formaldehyde resin.	**01**
05	To compare the rate of corrosion of various metals in acidic medium.	**01**
06	Determination of % purity of iron.	**01**
07	Determination of Sn from solders volumetrically.	**01**
08	Determination of unknown concentration of Cu in the given sample by colorimetry	**01**
09	Determination of unknown concentration of Fe in the given sample by colorimetry	**01**
10	Determine the unknown PH of sample by PH meter	**01**

List of Assignments:

Sr No	List of Assignments	Hrs
01	Numerical on determination of hardness of water and on determination of BOD and COD	**01**
02	Short note on advanced polymers used in electronics.	**01**
03	Short note on various corrosion control techniques	**01**
04	Short note on CNT.	**01**
05	Short note on smart alloys: some examples of smart polymers with their properties and uses.	**01**
06	Short note on Etching materials.	**01**

References:

1. Engineering Chemistry, Jain and Jain, Dhanpat Rai Publication
2. A textbook of Engineering Chemistry, S. S. Dara, S. Chand and Company
3. Polymer science: Vasant Gowarikar, Wiley Eastern Ltd, new Delhi
4. Green Chemistry: V. K. Ahluwalia
5. Textbook of Polymer science: F.W. Billmeyer
6. Fundamentals of Polymer science & Engineering- Anilkumar & S K Gupta, Tata McGraw Hill, New Delhi
7. Engineering Chemistry, O. G. Palana, Tata McGraw Hill Publication
8. Environmental Chemistry, A. K. De, Tenth edition, New Age International,
9. P. W. Atkins, Physical Chemistry, Oxford University Press, 7th edition. 5. J. D. Lee Concise Inorganic Chemistry, Oxford University Press, 5 th edition.

Online Resources:

Sr. No.	Website Name
1.	https://archive.nptel.ac.in/courses/103/106/105106205/
2.	https://courses.nptel.ac.in/noc20ch41/preview
3.	https://www.researchgate.net/

4.	https://www.sciencedirect.com/topics/engineering/polymer-material
5.	https://www.sciencedirect.com/topics/chemistry/nanomaterial

Assessment:

Term Work: Term Work shall consist of at least 10 practicals based on the above list. Also, Term work Journal must include at least 6 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14122206	Engineering Mechanics Lab	-	-	2	-	-	30	-	30	1

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT-1	IAT-2	Total.					
14122206	Engineering Mechanics Lab	--	--	--	--	--	25	25	50

Lab Objectives:

1 To acquaint with basic principles of Centroid and its real-life significance
2 To familiarize with the concepts of force, moment, couple, resultant and system of coplanar and non-coplanar forces.
3 To familiarize with the concepts loads, beams, equilibrium conditions, friction and their real-life applications.
4 To understand the motion parameters required for quantification of Kinematics of Particle and Rigid body.
5 To understand the combination of force and motion parameters required for quantification of Kinetics of rigid body.
6 To acquaint with the basics of Robot kinematics

Lab Outcomes:

1 Demonstrate the understanding of Centroid locate the same.
2 Determine the resultant and equivalent force-couple system for a given system of forces.
3 Illustrate the concept of loads, supports, beams, conditions of equilibrium, and friction and apply the same in two dimensional systems with the help of FBD.
4 Determine the position, velocity, and acceleration of particle and rigid body using principles of kinematics for rectilinear, curvilinear, and general plane motion.
5 Apply the principles of force and acceleration, work-energy and impulse-momentum to particles in motion.
6 Establish the relation between robot joints and parameters

List of Experiments:

Minimum six experiments from the following list of which a minimum one should be from dynamics.

Sr. No.	List of Experiments	Hrs	CO mapping
1	Verification of Polygon law of coplanar forces (Universal force table apparatus)	02	CO2
2	Verification of the Principle of Moments (Bell crank lever)	02	CO2
3	Determination of Centroid of plane lamina made up of standard geometrical shapes	02	CO1
4	Determination of support reactions of a Simply Supported Beam.	02	CO3
5	Determination of coefficient of friction using inclined plane	02	CO3
6	Verification of the equations of equilibrium for non-concurrent non-parallel (General) force system.	02	CO3
7	Kinematics of particles. (Uniform motion of a particle, Projectile motion, motion under gravity)	02	CO4
8	Collision of elastic bodies (Law of conservation of momentum).	02	CO5
9	Kinetics of particles. (collision of bodies)	02	CO5

Sr No	List of Assignments / Tutorials	Hrs	CO mapping
01	Centroid of composite plane laminas (3 Numerical)	01	CO1
02	Resultant of coplanar and non-coplanar system of forces (2 Numerical)	01	CO2
03	Equilibrium of beam, rollers, bodies on inclined plane with friction and ladders with friction (6 Numerical).	03	CO3
04	Kinematics of particles and rigid bodies (7 Numerical)	03	CO4
05	Kinetics of particles (3 Numerical)	01	CO5
06	Homogeneous transformation, and Direct Kinematics of robot (5 Numerical)	02	CO6
07	Resultant of Co-planar system of forces for concurrent system of forces using C programming language.	02	CO1
08	Equilibrium of beam for support reactions using C programming language	02	CO3

Assessment:

Term Work: Term Work shall consist of at least 06 practicals based on the above list. Also, Term work Journal must include all the assignments listed above.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical& Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

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Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
14122207	Programming Lab (Python)	2	--	2	30	--	30	--	60	2

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term work	Practical / Oral	Tut.	Total
		Internal assessment			End Sem. Exam				
		IAT-1	IAT-2	Total					
14122207	Programming Lab (Python)	--	--	--	--	25	25	--	50

Lab Objectives: To familiarize learners with Python's basic syntax, variables, data types, operators, and input/output functions.

1. To reinforce the understanding and application of conditional statements, loops, and functions in Python programming.
2. To instill learners on file handling, exception management, and Python packaging.
3. To introduce object-oriented programming principles and their application in Python.
4. To explore advanced topics such as regular expressions, pattern matching, and GUI development.
5. To introduce and demonstrate the use of popular Python libraries for data handling.

Lab Outcomes: After completion of experiment, the learners will be able to

1. Demonstrate the proficiency in basic python programming or create and perform various operations on data structures like list, tuple dictionaries and strings.
2. Apply Control Flow and Functions for efficient coding to solve problems.
3. Demonstrate proficiency in handling file operations, managing exceptions, and developing Python packages and executable files for modular programming.
4. Illustrate the concept of Object-Oriented Programming used in python.
5. Design Graphical User Interface (GUI) applications, utilizing appropriate Python libraries to create user-friendly interfaces.
6. Investigate and apply popular python libraries to conduct efficient data handling tasks.

Prerequisite:

1. Logical Thinking & Problem Solving: Ability to break down problems into smaller parts. Basic understanding of flowcharts or algorithmic thinking.
2. Mathematical Reasoning: Basic arithmetic operations (addition, subtraction, multiplication, division).
3. Understanding of variables, functions, and formulas (from school-level math).
4. Analytical Skills: Ability to spot patterns, debugs issues, and evaluates outputs.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Comment (Prerequisite syllabus should not be considered for paper setting)	**01**	
1	Introduction to Python	1.1 Evolution of Python & its role in modern tech stacks, Python in web development, data science, automation, AI.	**05**	**CO1**

		1.2 Basic Syntax and Data Types - Variables and data types, Operators, Input and output, 1.3 Real-world data modeling with Python data types (int, float, str, list, tuple, dict, set) 1.4 Operators with hands-on examples from finance, gaming, etc., Industry Task: Build a basic expense tracker using lists and dictionaries		
2	Control Flow and Functions	2.1 Conditional Statements: if-elif-else in decision- based apps 2.2 Loops (for, while) in automation & report generation, 2.3 Loop control: break, continue, pass 2.4 Functions- Defining functions, Parameters and return values, Scope and lifetime of variables	**05**	**CO2**
3	File Handling, Packaging, and Debugging	3.1 File Handling- Reading and writing files, 3.2 Exception handling 3.3 Creating Python Packages, Modules and executable files 3.4 Dealing with Syntax Errors, Runtime Errors and Scientific Debugging	**05**	**CO3**
4	Object-Oriented Programming (OOP) in Python	4.1 Introduction to OOP: Classes and objects, 4.2 Encapsulation, inheritance, and polymorphism 4.3 Creating Classes and Objects: Class attributes and methods Constructor and destructor.	**05**	**CO4**

		4.4 Type of Inheritance: Single, multiple and multilevel inheritance		
5	Advanced Python Concepts	5.1 Regular Expressions, Pattern matching, Regex functions in Python 5.2 GUI Development using any Python GUI framework	**05**	**CO5**
6	Python Libraries	6.1 Introduction to Popular Libraries 6.2 NumPy for numerical computing, 6.3 Pandas for data manipulation. 6.4 Matplotlib for data visualization functional ceramics, ceramic coatings.	**05**	**CO6**

Text Books:

1. Core Python Programming, Dr. R. Nageswara Rao, Second Edition, Dreamtech Press.
2. Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox Publication.
3. Python Programming, Anurag Gupta and G. P. Biswas, First Edition,McGraw-Hill

Reference Books:

1. Learn Python the Hard Way, Zed Shaw, Third Edition, Addison-Wesley.
2. Python Projects, Laura Cassell,Alan Gauld, First Edition, Wrox Publication.
3. Introduction to computing and problem-solving using python, Balagurusamy, First Edition, McGraw Hill Education.

Online Resources:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/106106145
2.	https://onlinecourses.swayam2.ac.in/cec22_cs20/preview

3.	https://www.researchgate.net/
4.	https://www.sciencedirect.com/science/article/pii/S2666920X24001127
5.	https://www.sciencedirect.com/search?qs=python%20programming

Suggested List of Experiments: (Expected Minimum 15 Experiments to be performed)

Sr No	List of Experiments	Hrs
01	To understand the structure and features of the Code: Blocks Integrated Development Environment (IDE) and to use it effectively for writing, compiling, debugging, and executing python programs, which will serve as the foundational tool for all further experiments in the lab.	**02**
02	Personalized Greeting Generator - Write a python code to generate Personalized Greeting.	**02**
03	Calculating Areas of Geometric Figures - Write a python program to calculate areas of any geometric figures like circle, rectangle and triangle.	**02**
04	Calculating Gross Salary of an Employee: Write a Python program to calculate the gross salary of an employee. The program should prompt the user for the basic salary (BS) and then compute the dearness allowance (DA) as 70% of BS, the travel allowance (TA) as 30% of BS, and the house rent allowance (HRA) as 10% of BS. Finally, it should calculate the gross salary as the sum of BS, DA, TA, and HRA and display the result.	**02**
05	Task List Manager: Develop a Python program to manage a task list using lists and tuples, including adding, removing, updating, and sorting tasks.	**02**
06	Student Record Keeper: Write a Python program to create, update, and manipulate a dictionary of student records, including their grades and attendance.	**02**

07	Triangle Pattern Generator Using Loops: Write a Python program to print a triangle pattern (give any), emphasizing the transition from C to Python syntax.	**02**
08	Number Type Identifier: Develop a Python program that takes a numerical input and identifies whether it is even or odd, utilizing conditional statements and loops.	**02**
09	**Grade Evaluator:** Develop a Python program that takes marks and evaluates grade using if-elif-else	**02**
10	**Fibonacci Sequence Generator:** Write a Python program to generate the first N terms of the Fibonacci series using loops.	**02**
11	Multiplication Table Generator: Write a Python program to take a numerical input from the user and generate its multiplication table using loops.	**02**
12	Extracting Words from Text File: Develop a Python program that reads a text file and prints words of specified lengths (e.g., three, four, five, etc.) found within the file.	**02**
13	Basic Exception Handling: Write a Python program that takes two numbers as input and performs division. Implement exception handling to manage division by zero and invalid input errors gracefully.	**02**
14	Online ATM System: Develop classes for ATM. Include methods for withdraw, deposit and check balance.	**02**
15	Password Strength Checker: Write a Python script that prompts the user to enter a password. Use regular expressions to validate the password based on these criteria: At least 8 characters long, Contains at least one uppercase letter, one lowercase letter, one digit, and one special character.	**02**

Assessment:

Term Work: Term Work shall consist of at least 15 practical based on the above list. Also, Term work Journal must include 1 mini project based on above syllabus.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (mini project) + 5 Marks (Attendance).

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30)
		L	T	P	L	T	P	SL	Notional Learning Hour	
14122208	IDEA LAB -2 (Innovation Design Engineering and Apply)	1	--	2	15	--	30	15	60	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT-1	IAT-2	Total				
14122208	IDEA LAB -2 (Innovation Design Engineering and Apply)	--	--	--	--	50	50	100

Rationale:

Aligned with the National Education Policy (NEP) 2020, the institution emphasizes experiential, interdisciplinary, and project-based learning through the IDEA Lab—a central hub for hands-on innovation.

To strengthen the undergraduate research ecosystem, the institution has adopted a theme-based academic model aligned with UN SGD. Each semester features six curated problem statements based on local need and aligned with core subjects in the same semester, enabling students to apply

classroom knowledge to real-world challenges. Every student selects one problem and develops an individual, subject-integrated solution—enhancing both academic understanding and research skills.

The IDEA Lab supports this initiative with facilities for design thinking, prototyping, and product development. Students maintain a project logbook throughout the semester to track their progress and reflections.

To ensure academic accountability, a two-tier assessment framework is implemented:

- Project Assessment based on standardized IDEA Lab rubrics.
- Subject-Based Term Work Assessment focused on the application of same-semester subject knowledge in the project.

Lab Objectives:

1. To promote experiential and project-based learning that bridges theoretical knowledge with real-world problem-solving.
2. To encourage interdisciplinary integration by enabling students to apply concepts from multiple subjects within a single cohesive project.
3. To develop innovation and design thinking skills through hands-on activities and iterative solution development.
4. To foster critical thinking and creativity by engaging students in open-ended problems with multiple solution pathways.
5. To enhance communication, collaboration, and documentation skills essential for professional engineering practice.
6. To build an entrepreneurial and research mindset by guiding students to develop scalable, socially-relevant, and technically viable prototype

Lab Outcomes: Student will be able to

1. Recall and articulate key concepts from core and allied subjects relevant to the assigned project.
2. Explain the interdisciplinary nature of the problem and the role of each subject in addressing it.
3. Apply appropriate tools, techniques, and theoretical knowledge to develop project components.
4. Analyze problem constraints and user requirements to structure a feasible and efficient solution.

5. Evaluate multiple design options and justify the chosen solution based on technical and practical considerations.
6. Create a functional prototype or solution that demonstrates innovation, utility, and integration of interdisciplinary knowledge

1) Guidelines for IDEA Project

a) Project Guidelines (Interdisciplinary Project Execution in IDEA Lab)

- Each student works on an individual interdisciplinary project aligned with the semester theme.
- Faculty in-charges for the IDEA Lab are assigned according to the complexity of the project and the capacity of the respective departments.
- Faculty in-charges mentor both the academic and technical aspects, and track weekly progress.
- Project assessment will be rubric-based, ensuring depth, innovation, documentation, and ownership.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- Faculty in-charges must attend relevant FDPs to ensure uniformity in mentoring and evaluation.

b) Guidelines for same semester Subject Concepts Applied within the Project

- Term work for each subject will partially reflect how well a student applies subject-specific concepts in their interdisciplinary project.
- Internal assessment panel will collaborate to align project components with subject learning outcomes.

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c) Role of Faculty In-Charges in IDEA Lab Projects

Faculty in-charges play a pivotal role in the success of interdisciplinary, theme-based projects under the IDEA Lab. Their responsibilities extend beyond technical supervision to include academic alignment, innovation facilitation, and active student engagement. Their key roles include:

1. **Motivating and Inspiring Students**
   - Encourage students to take ownership of their learning and projects.
   - Cultivate a mindset of curiosity, exploration, and social relevance.
   - Foster an environment where students feel empowered to take creative risks.
2. **Conducting Brainstorming and Ideation Sessions**
   - Organize structured brainstorming sessions at the start of the semester to help students define their problem statements and solution pathways.
   - Promote collaborative thinking, design exploration, and interdisciplinary integration.
3. **Arranging Guest Lectures and Expert Talks**
   - Identify and invite industry experts, researchers, and innovators for guest lectures aligned with the semester's theme or subject areas.
   - Facilitate exposure to real-world challenges, current trends, and future opportunities.
4. **Ensuring Uniqueness and Originality of Projects**
   - Actively review proposed ideas to ensure **no duplication of solutions** across students.
   - Encourage students to explore novel approaches, technologies, and perspectives.
5. **Promoting Discussion and Collaborative Learning**
   - Create platforms for students to present, discuss, and receive peer and mentor feedback.
   - Facilitate idea refinement through regular discussions and group engagement.
6. **Aligning Subject Content Beyond Syllabus**
   - Faculty in-charges must **align subject content beyond the syllabus of the same semester** with the **IDEA Lab theme and assigned problem statements**.
   - This ensures relevance, depth, and meaningful interdisciplinary integration.
7. **Same Semester Faculty Requirement**
   - Faculty in-charges must be teaching subjects in the **same semester** as the students' project to ensure seamless academic integration and contextual understanding.
8. **Monitoring and Documentation**
   - Oversee project logbook maintenance, milestone tracking, and submission of progress reports.
   - Provide ongoing feedback and ensure project alignment with learning outcomes.
9. **Coordination with Subject Faculty**
   - Work in collaboration with other subject faculty to help students embed theoretical and practical aspects of their coursework into the project.
   - Facilitate subject-term mapping and contribute to termwork assessment based on evidence.

2) Implementation Strategy

a) Project Implementation in IDEA Lab

Aspect	Implementation Strategy
Faculty in-charges	**Faculty in-charges assigned based on project nature and department capacity.**
Mentoring Role	**Faculty in-charges oversee academic/technical development, interdisciplinary integration, and timely documentation.**
Capacity Building	**Faculty in-charges undergo workshops on design thinking, innovation, assessment rubrics, and outcome-based mentoring.**
Assessment Contribution	**Faculty in-charges contribute to 25 marks allocated for the IDEA Lab project term work. The remaining assessments are conducted by the external examiner.**
Recognition & Incentives	**Faculty in-charges receive workload credits or are formally acknowledged in performance reviews.**

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b) Implementation of Subject-Term Work Mapping within Projects

Aspect	Implementation Strategy
Mapping Subject Outcomes	**Faculty in-charges align their content beyond syllabus with the student's project by coordinating with the assigned project guide.**
Independent Evaluation	**Internal assessment panel evaluate students based on their application of subject-specific concepts within the project. This contributes to a** separate 25 marks allocated for term work based on subject **application.**
Evidence Sources	**Evaluation is supported by project logbooks, subject-specific deliverables (e.g., tools, simulations, models), and review presentation inputs.**
Outcome Assurance	**Ensures practical demonstration of subject understanding and its integration into the interdisciplinary solution.**

Implementation Notes:

- Guide faculty assess their course's contribution using specific evidence such as:
    - Logbooks

- Subject-specific outputs (e.g., simulations, designs)
- Paper publications or review presentations

2) Guidelines for Assessment

Two-tier rubrics are applied independently to evaluate subject concept application and innovation within the project.

a) Assessment of IDEA Lab Projects (Individual Interdisciplinary Projects) (25 Marks)

Presentation-Based Assessment Structure (Total: 25 Marks)

Assessment Month	Weightage	Marks
Month 1 (Formative 1)	20%	5 marks
Month 2 (Formative 2)	40%	10 marks
Month 3 (Formative 3)	40%	10 marks

Rubric-Based Evaluation Criteria

Criteria	Month 1 (5)	Month 2 (10)	Month 3 (10)
Problem Understanding	Connects problem to subjects	Defines interdisciplinary scope	Demonstrates deep conceptual grasp
Subject Knowledge Application	Identifies relevant concepts	Applies principles in design	Integrates multiple subject areas correctly
Innovation & Design Thinking	Proposes creative idea	Develops and tests feasible solution	Final solution shows originality and utility
Documentation & Presentation	Logbook initiated, plan presented	Mid-design log and visuals	Final report and demo completed
Progress & Ownership	Meets deadlines, shows planning	Demonstrates self-motivation	Completes project independently with reflection

b) Term Work Assessment of Subject Concepts Applied in Projects (25 Marks)

Applicable to All Subjects Integrated with Interdisciplinary Projects

To reflect meaningful application of subject knowledge, each subject will be assessed through the following rubric:

Criteria	**Marks**	**Description**
Subject Knowledge Application	8	Depth and accuracy of concept integration into the project
Practical Design or Tool Usage	5	Use of subject-specific hardware/software/simulation/tools
Documentation	4	Quality and clarity of subject-related logs and reports
Viva/Presentation	4	Ability to explain subject's relevance and role in the project
Continuous Engagement	4	Evidence of consistent participation via logbooks and feedback

c) Total Assessment Structure

Component	Marks	Assessed By
Term work – Project Execution	25 Marks	Project Guide
Term work – Application of Subject Concepts	25 Marks	IDEA Lab Panel
Viva Voce (Final Evaluation)	50 Marks	External Examiner

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14212209	Elements of Telecommunication Lab	--	--	02	--	--	30	--	30	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT-1	IAT-2	Total				
14212209	Elements of Telecommunication Lab	--	--	--	--	25	25	50

Lab Objectives:

1. To demonstrate generation and detection of analog modulation techniques.
2. To demonstrate generation and detection of digital modulation techniques.
3. To illustrate the different computer network topology.
4. To illustrate the use of various AT commands in GSM modules and to analyze key parameters of Wi-Fi networks.
5. To make use of modern tools for simulation of communication systems.
6. To provide practical experience in simulating satellite communication.

Lab Outcomes:

1) Demonstrate the concepts of AM and FM

2) Compare digital modulation techniques PCM, ASK, FSK
3) Simulate a computer network using various network components.
4) Use of AT Commands in mobile device
5) Setting up of optical fiber link
6) Simulate satellite communication scenarios.

Prerequisite: Physics and Basic Mathematics

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Basic knowledge of **electronic components and circuits** (resistors, capacitors, transistors), Understanding of **signal types** (analog and digital) and basic waveform characteristics (frequency, amplitude, phase), Familiarity with **fundamental physics concepts** related to waves and electromagnetic spectrum, Basic computer literacy and exposure to **circuit simulation tools** (e.g., Multisim, MATLAB, Packet Tracer) is advantageous.		
I	Fundamentals of Analog Communication	Modulation and Demodulation Techniques like AM and FM.	6	LO1
II	Principles of Digital Communication	Digital Modulation technique like PCM, ASK, FSK	6	LO2
III	Computer and Data Communication Networks	Network topologies and devices. Implementation of above topologies using open-source soft wares	6	LO3

IV	Mobile and Wireless Communication Systems	AT commands for GSM. Demonstrate AT commands. To know and study various parameters of Wi-Fi / Access points	4	LO4
V	Fiber Optic Communication and Photonics Applications	Components of Fiber Optic Communication	4	LO5
VI	Satellite and Space Communication	Components of Satellite Communication	4	LO6

Text Books:

1. "Electronics Communications System" by George Kennedy.
2. “Optical Fiber Communications” by Gerd Keiser, 5th Edition
3. "Data Communications and Networking" by Behrouz A. Forouzan, Fifth Edition TMH, 2013.
4. T. Pratt, C. Bostian, and J. Allnutt, *Satellite Communications*, 2nd ed., Wiley, 2002.

References:

1. Simon Haykin, “Communication Systems”, 4th Edition, John Wiley & Sons, 2004.
2. Optical Fiber Communication: Principles and Practice, John M. Senior, 3rd edition.
3. M. Richharia and L. K. T. S. Mhurchu, *Satellite Communications Systems: Systems, Techniques and Technology*, 6th ed., Wiley, 2020.

Online Resources:

Sr. No.	Website Name
1.	Analog https://swayam.gov.in/nd1_noc20_ee69/preview
2.	https://nptel.ac.in/courses/108/101/108101113/
3.	http://nptel.ac.in/courses/117104099/ - (Advanced 3G and 4G Wireless Mobile communications)

List of Experiments.

Sr No	List of Experiments	Hrs
01	Simulation /Hands on modulation techniques AM	2
02	Simulation /Hands on modulation techniques FM.	2
03	Simulation /Hands on digital techniques PCM.	2
04	Simulation /Hands on digital techniques ASK.	2
05	Simulation /Hands on digital techniques FSK.	2
06	Simulation/Setting up of star topology using packet tracer (Open-Source Software).	2
07	Simulation/Setting up of ring topology using packet tracer (Open-Source Software).	2
08	Simulation/Setting up of mesh/tree topology using packet tracer (Open-Source Software).	2
09	Simulation/Setting up of bus topology using packet tracer (Open-Source Software).	2
10	Test the AT commands on mobile devices using open software.	2
11	To study parameters of Wi-Fi (IEEE 802.11)	2
12	Simulation of Satellite Communication System.	2
13	Setting up/ Simulate Analog fiber optic communication System using open-source software	2
14	Setting up/ Simulate Digital fiber optic communication System using open-source software	2

Sr No	List of Assignments / Tutorials	Hrs
01	Assignment based on Module 1, 2 &3	
02	Assignment based on Module 4, 5 &6	

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practicals' based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical& Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

R-2025- F.E. Electronics and Telecommunication Engineering

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					
		L	T	P	L	T	P	SL	Notional Learning Hour	Total Credits (C) (Notional Learning Hour/30)
14412210	Workshop - 2	--	--	2	--	--	30	15	45	1.5

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT-1	IAT-2	Total				
14412210	Workshop - 2	--	--	--	--	25		25

Lab Objectives:

1. To introduce students to basic IOT and embedded systems by programming a NODE MCU ESP8266 micro controller to blink an LED.
2. To understand the basic working principle infrared (IR) sensors and role in detecting line contrast.
3. To introduce students to fundamental robotics concepts through the assembly and programming of a basic line following robot.
4. To understand flight dynamics, sensor integration, remote control systems, and applications of drones in real-world.
5. To familiarize student with component and operation of 3D printer.
6. Identify different types of 3D printers (FDM, SLA, SLS) and their components.

Lab Outcomes: At the end of the course, the student will be able to

1. Able to collect data from sensors and control actuators using boards like Arduino, NodeMCU, or Raspberry Pi.
2. Able to Write and implement code to control robotic motion using microcontrollers like Arduino, Raspberry Pi, or other platforms.
3. Able to design, implement, and test a line following robot that autonomously follows a predefined path using infrared (IR) sensors.
4. Able to Perform printer setup, filament loading, calibration, and execute the printing process successfully.
5. Able to understand the fundamentals of additive manufacturing and to fabricate a physical 3D model using Fused Deposition Modeling (FDM) technology.
6. Able to operate a drone using a remote controller and execute programmed missions using waypoint navigation.

Detailed Syllabus

Sr No	Name of Module	Detailed content	Hours	Lo
1	**Introduction to IOT and Embedded system**	Programming a NodeMCU ESP8266 microcontroller to blink an LED. ● Introduction to NODE MCU and IOT. ● Circuit setup and IDE configuration. ● Setting up Arduino IDE for ESP8266. ● Experimenting Variation and Discussion Self Learning Connect the DHT sensor to the NodeMCU. Write and upload a program using Arduino IDE to read temperature data. Write and upload a program using Arduino IDE to read temperature data. Send the data to Thing Speak (or any IoT dashboard). Visualize the readings on a real-time graph.	**8** **4**	**LO1**
2	**Introduction to Robotics**	Programming a basic line following robots ● Introduction to robotics and components ● Assembling a line following robots ● Programming the robot. ● Testing and evaluation. Self Learning Build and Control a Basic Line-Following Robot (Modify the code to adjust speed based on curves.)	**8** **4**	**LO2** **LO3**

3	**Introduction to 3D Printing**	To design and print your first object ● Introduction and basics. ● 3d modelling ● Slicing and preparing the print ● Printing and reviewing. Self learning Explore process parameter of 3d printer Explore 2d and 3d drafting and modelling	**8** **2**	**LO5** **LO6**
4	**Introduction to drone technology**	Introduction to drone ● Components familiarizations ● Drone assembly ● Calibration and coding upload ● Flight testing and troubleshooting Self Learning Studying basic principle of drone Studying drone programming Basic drown fundamentals	**8** **3**	**LO4**

Reference Book

1. IoT: Building Arduino-Based Projects by Peter Waher.
2. Robotics: Modelling, Planning and Control by Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo.
3. 3D Printing: A Practical Guide for Librarians by Sara Russell Gonzalez, Denise Beaubien Bennett.
4. Make: DIY Drones for the Evil Genius by Ian Cinnamon.

Online Resources

Sr No	Reference
1	https://onlinecourses.nptel.ac.in/noc21_cs17 -Introduction to internet of things, by Prof. Sudip Misra , IIT Kharagpur
2	https://onlinecourses.nptel.ac.in/noc21_cs08 -Embedded Systems Design, By Prof. Anupam Basu, IIT Kharagpur
3	https://onlinecourses.nptel.ac.in/noc25_ae30/preview -Drone Systems and

	Control, By Prof. Suresh Sundaram, Dr. Rudrashis Majumder
4	https://onlinecourses.swayam2.ac.in/ntr25_ed66/preview - 3D Printing and Design for Educators, By Dr. Sharad K. Pradhan

Suggested list of Experiments:

Sr No	List of Experiments	Hrs.
01	Blinking LED with Node MCU.	8
02	Built and test basic Line following robot	8
03	Design and Print your first object.	8
04	To assemble and understand working of mini drone.	6

Assessment:

- **Term Work Marks:** 25 Marks (Total marks)
- **Job and Manual: -** 20 Marks
- **Regularity and active involvement:** - 5 Marks

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
98441211	Indian Knowledge System	2	--	--	30	--	--	30	60	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT-1	IAT-2	Total.					
98441211	Indian Knowledge System	20	20	40	60	2.5	--	--	100

Rationale:

The Indian Knowledge System (IKS) is vital for preserving India's rich cultural heritage, fostering holistic and sustainable practices, and integrating ancient wisdom with modern science to address contemporary challenges and enrich global knowledge.

Course Objectives:

1. To explore and understand the evolution of Indian scientific thought
2. To evaluate the historical and modern educational systems in our country.
3. To analyse sustainable practices in in ancient India.
4. To know the richness of Indian Arts and Culture
5. To understand the contributions of Indian Scientists and Nobel Laureates
6. To understand the principles of good governance.

Course Outcomes:

1. Recognize the sources and concepts of the Indian knowledge system
2. Learn about our history of Indian ancient knowledge and its significance in the current scenario.
3. Demonstrate sustainable development in various fields like Science, Technology, agriculture, industry, architecture performing arts, etc.
4. Understand and appreciate the rich heritage that resides in literature
5. Learn about the ancient Bhartiya education system in comparison with the modern era
6. Showcase the multi-dimensional nature of IKS and its importance in modern

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	1.Students should have the foundational knowledge and skills necessary for a comprehensive understanding of IKS 2. Students should be familiar with the Indian Culture, Language, and History of Science and Technology in India.		
I	**Introduction to The Indian Knowledge**	Basic knowledge and scope of IKS, IKS in ancient India and modern india,, Preservation of culture, tradition and Dharma through education. Sources of Education, Aim of Education, Curriculum, methods of learning,	5	CO2

	System (I.K.S.)	Reviving, Knowledge (Ancient Scientific Discoveries) **Self-Learning Topics: Macaulay's Education Policy and Max Mullar Ideology in destroying Indian Tradition**	5	
II	**Development of Scientific Thoughts in Ancient India**	Development in Science, Technology, Astronomy, Mathematics, and Life Sciences – Life Science, Physiology, Ayurveda, etc. Discoveries during Ancient times **Self-Learning Topics: Technological Innovations in Ancient India, Architecture and Engineering**	5 5	CO1
IV	**Good Governance in Ancient India**	Introduction to Indian religions,Moral and Ethical Governance,Vishva Kalyan through Vasudhaiva Kutumbkam,Principles of Good Governance about Ramayana, Mahabharat, Artha Sastra and Kauṭilyan State,Scientific Explanation of Vedic or traditional system of society for Good Governance **Self-Learning Topics:Governance Models and Kingdoms, Court System and Judges, Crime, Punishment & Fairness**	5 5	CO6
V	**Contribution of Indian Scientist & Nobel Laureates**	Baudhayan, Aryabhatta, Brahmgupta, Bhaskaracharya, Varahamihira, Nagarjuna, Susruta, Kanada & Charak Rabindranath Tagore, C.V. Raman, Har Gobind Khorana, Mother Teresa, Subrahmanyan Chandrasekhar, Amartya Sen, V.S. Naipaul, Venkatraman Ramakrishnan, Kailash Satyarthi and Abhijit Banerjee **Self-Learning Topics: Indian Contributions to Global Science**	5 5	CO5

VI	**Sustainable Practices in Ancient India**	Agriculture, waste management, water conservation, forest conservation, architecture, urban planning, biodiversity preservation, etc Yoga, Pranayama, and meditation for health and well-being. **Self-Learning Topics: Vaastu Shastra Principles, Minimalism and Non-materialism**	5 5	CO3
		Total	60	

Text Books:

1. B. L. Theraja – Textbook of Electrical Technology, Prentice Hall of India (PHI)
2. B.R Patil – Basic Electrical Engineering, Oxford Higher Education
3. V. N. Mittal and Arvind Mittal – Basic Electrical Engineering, Tata McGraw Hill
4. V. K. Mehta – Principles of Electronics, S. Chand Publishing, New Delhi 7
5. R. S. Sedha – A Textbook of Applied Electronics, S. Chand Publishing, New Delhi
6. Digital Fundamental, 8th edition, Floyd and Jain, Pearson Education India, 2005
7. Electric Motors and Drives Fundamentals, Types and Applications, 3 rd Edition, Austin Hughes, Newnes Publisher.

References:

1. Introduction to Electrical Engineering, M. Naidu, S. Kamakshaiah, McGraw-Hill Education, 2004
2. S. N. Singh, “Basic Electrical Engineering” PHI, 2011
3. Electrical and Electronic Technology, 10th edition Edward Hughes, Pearson Education.

Online References:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/108108076
2.	https://www.nesoacademy.org/ec/04-analog-electronics/02-semiconductor-diode/01-pn-junction-diode-no-applied-bias
3.	https://onlinecourses.nptel.ac.in/noc21_ee55/preview

4.	https://onlinecourses.nptel.ac.in/noc20_ee60/preview
5.	https://archive.nptel.ac.in/courses/108/105/108105113/

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
98462212	NSS & Civil Defense	-	-	4*	-	-	60	-	60	2

*: Students need to complete 60 hours throughout the semester as it is not possible to get 4 hours /week due to the dynamic schedule of the Government agencies.

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT-1	IAT-2	Total					
98462212	NSS & Civil Defense	--	--	--	--	--	25	--	25

Rationale:

The National Service Scheme (NSS) is a central sector scheme of the Government of India aimed at developing the personality of students through community service. The NSS syllabus is designed with a strong rationale that aligns with the educational, social, and developmental goals of the nation. The NSS syllabus promotes the all-round development of students by instilling values such as discipline, leadership, empathy, and teamwork. It encourages experiential learning beyond the classroom, complementing academic education.

Course Objectives:

1. To Introduce National Service Scheme to learners and explain how it is used in current social studies.

2. To make the students aware of the need of having a foundation in social science and NSS.
3. To develop the personality of NSS volunteers through community service. It can enhance the personal growth and social skills of students.
4. To introduce students to social concepts and issues in society, as well as to get involved in resolving social issues.
5. To equip NSS volunteers with basic skills in civil defense, first aid, fire safety, and crowd management, enabling them to act as first responders during emergencies.
6. To build awareness, preparedness, and responsiveness among NSS volunteers to effectively assist in disaster situations.

Course Outcomes:

1. **Describe** the fundamentals and history of the National Service Scheme (NSS), with specific reference to its role in social work and nation-building.
2. **Demonstrate** understanding of NSS-related procedures, including organizational structure, volunteer enrollment, and activity planning.
3. **Participate** in community-based social service activities such as voter awareness drives, campus cleanup, tree plantation, and cyber safety campaigns.
4. **Develop** leadership, team-building, and project management skills through planning and executing NSS activities.
5. **Explain** the basic concepts of civil defence and disaster response mechanisms.
6. **Apply** practical skills in fire safety, first aid, and emergency management during simulated and real-life situations.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite			
I	Leadership & Personality development	Meaning, definition, qualities, and characteristics of a Leader. Meaning of personality, Dimensions of personality. Personality and Leadership nexus. Universal Human Values and Ethics for youths, Sustainable Development Goals	6	Co1

II	Activity Based programs	(Colleges can plan various social activities for learners and make a detailed report) Activities can be conducted throughout the academic year. Evaluation will be based on record keeping of the attendance of the learner.	10	CO2
III	Awareness based programs	Awareness Programs such as Rally, Seminar, Workshops, poster making, theme based rangoli making, essay writing, slogan writing, quizzes, Celebration of National and International days, Personality Development programs, Group Activities, etc.	10	CO3
IV	Area Based Projects	Visit to Adopted villages, Swatchatha \Program, Visit and Conserving Ancient monuments and heritage site, Socio Economic Survey of village/slum, Nature Camp, Environmental Education, Women Empowerment Program, Health and hygiene program and Blood donation, Legal awareness Program, Literacy Program, Cyber theft awareness Water Conservation Program and RWH, One Day Special Camp in a village (preferably in adopted village/Adopted areas/Slums/MR Schools etc.).	14	CO4
V	Introduction to Civil Defense and Disaster Management	Definition and objectives of civil defense, Structure and functions of the Civil Defense Organization, Types of disasters: natural and man-made, Phases of disaster management: prevention, preparedness, response, recovery, NDMA (National Disaster Management Authority) and its role, Role of youth in disaster management	10	CO5
VI	Basics of Fire Safety and First Aid	Types of fires and fire extinguishers, Basic fire-fighting techniques, First aid for common injuries: bleeding, fractures, burns, CPR, Emergency numbers and response protocol, Evacuation techniques	10	CO6
		Total	60	

Text Books:

1.National Service Scheme Manual 2006, Government of India

2. Salunkhe P.B. Ed, Chhatrapati Shahu the Pillar of Social Democracy

3. National Service Scheme Manual, Govt. of India

4. Training Programme on National Programme Scheme TISS

5. Orientation Courses for N.S.S. Programme Officers, TISS

Online References:

Sr. No.	Website Name
1.	https://nssmu.in
2.	https://nss.gymkhana.iitb.ac.in/home

Assessment:

Term work (TW) for 25 marks:

- Term Work (TW) will comprise a report submitted by the students, detailing the 60 hours of social service completed during the semester as per the assigned projects and activities.

4. S.E Syllabus

Department of Electronics and Telecommunication Engineering

SEM III

Preface:

Theme: Sustainable Design in Electronic Devices and Linear Circuits

Aligned with UNSD GOALS: 2:- Zero Hunger, 4:-Quality Education, 7:- Affordable and Clean Energy, 9: Industry, Innovation, and Infrastructure,11:-Sustainable Cities and Communities, 13:-Climate Action

Keywords:*energy access, connectivity,resource efficiency and rural and semi-urban areas*

Description:

This semester's theme, "**Sustainable Design in Electronic Devices and Linear Circuits**," focuses on integrating environmental responsibility and long-term viability into the core principles of electronics engineering. It goes beyond traditional circuit design to emphasize creating electronic solutions that are energy-efficient, minimize waste, and are optimized for resource-constrained environments, particularly in rural and semi-urban areas. This approach directly addresses critical global challenges related to sustainable development.

Students will develop a sustainable mindset in electronics design, focusing on critical challenges in rural and semi-urban areas, including energy access, connectivity, and resource efficiency. The curriculum emphasizes low-power circuit design, energy-efficient embedded systems, and environmentally responsible technologies.

Alignment with UNSDG Goals:

- **UNSDG 2: Zero Hunger:** Contributes to ending hunger and achieving food security by enabling the design of smart, sustainable electronic solutions for agriculture, such as efficient irrigation systems and real-time post-harvest monitoring, which reduce food waste and improve crop yields in rural areas.
- **UNSDG 9: Industry, Innovation, and Infrastructure:** Supports this goal by fostering innovation in sustainable electronics design for resilient infrastructure, including low-power communication systems and smart monitoring solutions, thereby enhancing digital access and supporting the development of robust, accessible technology in underserved communities.
- **UNSDG 4: Quality Education:** Fosters quality education by equipping students with specialized skills in sustainable electronics design, addressing real-world challenges in underserved areas, and promoting environmentally conscious engineering.
- **UNSDG 7: Affordable and Clean Energy:** Directly contributes by focusing on low-power circuit design and energy-efficient systems, crucial for developing affordable and reliable energy solutions, especially in areas with unreliable power infrastructure.
- **UNSDG 11: Sustainable Cities and Communities:** Supports this goal by developing sustainable electronic devices for improved connectivity and efficient resource management, benefiting both rural and semi-urban communities and contributing to their resilience.
- **UNSDG 13: Climate Action:** Promotes climate action through an emphasis on reducing e-waste, promoting component sustainability, and designing energy-efficient systems, thereby reducing the carbon footprint of electronic devices and mitigating environmental impact.

Problem Statement:

1.Agriculture in India's rural areas suffers from unreliable electricity and water scarcity. Traditional, inefficient irrigation methods (manual or diesel pumps) lead to high costs, carbon emissions, and reduced crop yields, making these communities vulnerable. **(UNSD Goal 7: Affordable and Clean Energy)**

2.Remote Indian villages face slow and inefficient information dissemination due to limited digital access and unreliable infrastructure. Traditional methods fail to deliver timely updates (e.g., government schemes, health alerts, emergencies), impacting community awareness, access to services, and overall resilience.(**UNSD Goal 9: Industry, Innovation, and Infrastructure)**

3.Rural roads across many parts of India lack adequate lighting, creating safety hazards for commuters at night. Existing continuous lighting leads to significant energy wastage, light pollution, and unsustainable operational costs for resource-limited rural municipalities.(**UNSD Goal 11: Sustainable Cities and Communities)**

4.Rural India suffers **significant post-harvest losses** of agricultural produce due to **improper storage conditions (high humidity/temperature)**, causing spoilage and pest issues. This directly impacts **food security and farmer income**, perpetuating waste due to a **lack of real-time monitoring** for timely intervention.(**UNSD Goal 2: Zero Hunger)**

5.Rural homes near Virar Vasai face a high risk of devastating fires due to combustible materials, faulty wiring, and poor fire safety infrastructure. Delayed emergency response from limited communication and poor roads worsens impacts, causing significant loss of life, property, and livelihoods.(**UNSD Goal 3: Good Health and Well-being**)

6.Rural agricultural regions in India, suffer significant post-harvest losses of perishables due to uncontrolled temperature and humidity in storage. This spoilage results in major economic loss for farmers and alarming food waste, exacerbated by the lack of affordable, real-time monitoring and adaptive control, undermining agricultural sustainability and food security. (**UNSD Goal 12: Responsible Consumption and Production)**

Department of Electronics and Telecommunication Engineering

SEM IV

Theme: Smart and Sustainable Communication Systems for Resilient Communities

Aligned with UNSDG GOALS:-3: Good Health, 4:Quality Education, 9:Innovation, 10: Reduced Inequalities 11:Sustainable Cities and Communities, 12:Responsible Consumption, 13:Climate Action

Keywords:*disaster preparedness, digital inclusion, efficient resource management, and enhancing public services*

Description:

This semester's theme, "**Smart and Sustainable Communication Systems for Resilient Communities**",delves into the crucial role of communication technologies in building strong, adaptable, and self-sufficient communities. It emphasizes designing communication solutions that are not only technologically advanced "**Smart**" but also environmentally conscious, resource-efficient, and long-lasting "**Sustainable**". The focus extends to ensuring these systems can withstand disruptions and support communities through various challenges, making them "**Resilient**." This theme explores how reliable and efficient communication can underpin societal well-being, economic opportunity, and environmental protection across diverse settings, from bustling urban centers to remote villages.

Students will explore how reliable and sustainable communication technologies can address critical challenges in diverse communities, from urban centers to remote villages. Emphasizing disaster preparedness, digital inclusion, efficient resource management, and enhancing public services, the curriculum will equip students with practical skills to design efficient, environmentally responsible, and durable communication solutions.

Alignment with UNSDG Goals:

- **UNSDG 3: Good Health and Well-being**: By enhancing public services through reliable communication, students can contribute to health monitoring, emergency response, and overall well-being in communities.
- **UNSDG 4: Quality Education**: Provides a high-quality, practical education focused on designing sustainable and impactful communication systems, equipping students with skills vital for community development.
- **UNSDG 9: Industry, Innovation, and Infrastructure**: Fosters innovation in communication technologies and infrastructure development, particularly for challenging environments, thereby strengthening regional infrastructure.
- **UNSDG 10: Reduced Inequalities:** Directly addresses digital inclusion by focusing on reliable communication for remote areas, bridging the technological gap and ensuring equitable access to information and services.
- **UNSDG 11: Sustainable Cities and Communities**: Supports the development of resilient communities through improved communication for disaster preparedness, efficient resource management, and enhanced public services.

- **UNSDG 12: Responsible Consumption and Production:** Encourages the design of durable, energy-efficient, and sustainable communication systems, promoting responsible consumption of resources and reducing electronic waste.
- **UNSDG 13: Climate Action:** Contributes to climate action by promoting energy-efficient communication solutions and leveraging technology for better disaster preparedness and early warning systems in the face of climate-related events.

Problem Statement:

1.Semi-urban and rural areas in India, including regions like Mira Bhayandar and Vasai Virar, face an escalating threat from untreated wastewater discharge. This contaminates vital water sources, causing widespread public health issues (like waterborne diseases) and severe ecosystem degradation. The absence of affordable, real-time monitoring prevents timely detection and effective intervention.**(UNSD Goal 6: Clean Water and Sanitation)**

2.Maintaining critical infrastructure (like bridges and pipelines) across India is challenged by remote, harsh environments and vast distances. The lack of affordable, real-time monitoring leads to delayed detection of issues, risking catastrophic failures, economic losses, and service disruptions for communities.(**UNSD Goal 9: Industry, Innovation, and Infrastructure**)

3.Ensuring student and staff safety in remote/under-resourced schools across India (including Mira Bhayandar's periphery) is challenging due to limited communication infrastructure, lack of security systems, and delayed emergency response. This vulnerability risks critical incidents, impacting school well-being and education.(**UNSD Goal 4: Quality Education)**

4.Basic healthcare in remote Indian villages is severely hampered by a lack of real-time patient data and communication with urban specialists. This leads to delayed diagnoses, suboptimal treatment, and health disparities, compromising rural well-being due to slow, error-prone manual systems.(**UNSD Goal.3: Good Health and Well-being**)

5.Forest fires in India pose a significant and escalating threat to communities and biodiversity due to vast, unmonitored areas causing late detection. Delayed response from poor communication leads to rapid spread, extensive ecological damage, air pollution, and economic losses, compromising environmental sustainability and community resilience.(**UNSD Goal 13: Climate Action)**

6.India's energy distribution networks, particularly in semi-urban and rural areas, suffer from inefficient management and widespread power theft. This results in major energy losses, unreliable supply, and financial strain on utilities, leading to frequent blackouts, disrupted industries, hindered development, and compromised energy security and sustainability. Existing monitoring methods are inadequate.((**UNSD Goal 7: Affordable and Clean Energy**)

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Course Code	Course Name	Teaching Scheme (Contact Hours Per week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14211301	Mathematics for Signal Analysis	2	1	--	30	15	--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
14211301	Mathematics for Signal Analysis	20	20	40	60	2.5	25	--	125

Rationale:

In a second-year Electronics and Telecommunication Engineering course, understanding transform techniques and system analysis is fundamental for signal processing and communication system design. The Laplace transform is essential for analyzing continuous-time signals and systems, enabling engineers to solve differential equations related to circuit responses, such as transient analysis of RLC circuits. The inverse Laplace transform allows recovery of time-domain signals from the Laplace domain, which is critical for interpreting system behavior and designing stable circuits. Fourier series decompose periodic signals into harmonic components, useful in analyzing and synthesizing communication signals like amplitude or frequency modulated waves. The Fourier transform extends this to aperiodic signals, enabling spectrum analysis of signals and filtering applications in both time and frequency domains. The Z-transform is vital for discrete-time signal processing and digital system analysis, such as stability and frequency response of digital filters. Lastly, understanding Continuous and Discrete Time Linear Time-Invariant (LTI) systems is crucial for designing and analyzing analog and digital systems, including filters and

communication channels. These concepts collectively provide students with tools to analyze, design, and optimize complex telecommunication systems and signal processing applications.

Course Objectives:

1. To understand and apply Laplace transform techniques to solve differential equations in continuous-time systems.
2. To learn methods to find inverse Laplace transforms to convert Laplace domain functions back to time domain.
3. To comprehend and represent periodic signals as sums of sinusoids using Fourier series.
4. To understand and apply Fourier transform for analyzing aperiodic signals in frequency domain.
5. To understand Z-transform concepts for discrete-time signal and system analysis.
6. To learn properties and analysis of continuous and discrete-time LTI systems.

Course Outcomes:

1. Students will be able to analyze circuit responses and solve transient behavior problems using Laplace transforms.
2. Students will be able to determine time-domain signals from Laplace domain expressions and interpret system responses.
3. Students will be able to decompose periodic signals and synthesize communication signals using Fourier series.
4. Students will be able to apply Fourier transform techniques to analyze signal spectra and design frequency-selective systems.
5. Students will be able to analyze discrete-time systems and design digital filters using Z-transform methods.
6. Students will be able to model, analyze, and evaluate the behavior of analog and digital lti systems in practical applications.

Prerequisite:

1. Basics of integration and it's properties

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DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	Laplace Transform	Definition of Laplace transform, Condition of Existence of Laplace transform.	05	CO1
		Laplace Transform (L) of Standard Functions like e^{at}, $sin(at), cos(at), sinh(at), cosh(at)$ and $t^n, n \geq 0$.		
		Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by *t*, Division by *t,* Laplace Transform of derivatives and integrals (Properties without proof).		
		Evaluation of integrals by using Laplace Transformation.		
		Self-learning Topics: 1. Heaviside's Unit Step function. 2. Laplace Transform. of Periodic functions. 3. Dirac Delta Function.	10	
II	Inverse Laplace Transform	Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivatives.	05	CO2
		Partial fractions method to find inverse Laplace transform		
		Inverse Laplace transform using Convolution theorem (without proof).		
		Self-learning Topics: 1. Applications of Laplace Transforms for solutions to ODE to electrical & electronics circuit problems. 2. Applications to solve initial and boundary value problems involving ordinary differential equations.	10	

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III	Fourier Series	Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof).	05	CO3
		Fourier series of periodic function with period 2π and $2l$.		
		Fourier series of even and odd functions.		
		Self-learning Topics: 1. Half range Sine and Cosine Series. 2. Complex form of Fourier Series. 3. Fourier Integral	10	
IV	Fourier Transform	Fourier transform, Fourier Transform of Heaviside Unit step Function and Dirac Delta Function.	05	CO4
		Linearity Property, Time shifting Property, Frequency Shifting Property.		
		Convolution and Modulation property.		
		Self-learning Topics: 1. Standard Signals-Stop. 2. Input Signals. 3. Delta Signals. 4. Exponential Signals.	10	
V	Z-Transform	Definition and Region of Convergence,	05	CO5
		Transform of Standard Functions: $\{k^n a^k\}$, $\{a^k\}$, $\{c^k \sin(\alpha k+\beta)\}$, $\{c^k sinh\alpha k\}$, $\{c^k \cos(\alpha k+\beta)\}$, $\{c^k cosh\alpha k\}$		
		Properties of Z Transform: Change of Scale, Shifting Property, Multiplication, and Division by k.		
		Convolution theorem.		
		Inverse Z transform: Partial Fraction Method		
		Self-learning Topics:	10	

		1. Initial value theorem. 2. Final value theorem. 3. Inverse Using Convolution Theorem. 4. Inverse using Binominal expansion. 5. Inverse using long division.		
VI	Continuous and Discrete time LTI systems	Relation between continuous time Fourier Transform and Laplace Transform.	05	CO6
		Causality and stability of systems in *s*-domain, Total response of a system.		
		Relation between *z* transform and discrete time Fourier Transform		
		Systems characterized by Linear constant coefficient difference equation, Transfer Function		
		Plotting poles and zeros of a transfer function, causality and stability of systems. Total response of a system.		
		Self-learning Topics: 1. System representation, continuous time and discrete systems, system with and without memory. 2. Causal and non-causal system, linear and nonlinear system, time invariant and time variant system, stable system. 3. Representation of systems using differential /difference equation, Impulse, step and exponential response. 4. System Stability and Causality.	10	

Text Books:

1. Grewal B. S.: "Higher Engineering Mathematics", Khanna Publishers, 44th Ed., 2021.

2. Kreyszig E.: "Advanced Engineering Mathematics", John Wiley & Sons, 10th Ed., 2018.

3. Dass H. K.: "Higher Engineering Mathematics", S Chand & Company Ltd, 12th Ed., 2004.

4. Narayan S.: "Differential Calculus", S.Chand Publications, 30th Ed., 2005.

5. Nagoor Kani, Signals and Systems, Tata McGraw Hill, Third Edition, 2011.

6. Rodger E Ziemer, William H. Tranter and D. Ronald Fannin, Signals and Systems, Pearson Education, Fourth Edition 2009.

7. Alan V. Oppenhiem, Alan S. Willsky and S. Hamid Nawab, Signals and Systems, Prentice-Hall of India, Second Edition, 2002.

8. Simon Haykin and Barry Van Veen, Signals and Systems, John Wiley and Sons, Second Edition, 2004.

References:

1. Stewart J.: "Multivariable Calculus" Cengage Publications, 7th Ed., 2019.

2. Bali N.P and Goyal M.: "A Textbook of Engineering Mathematics" Laxmi Publications, 10th Ed., 2022.

3. Wylie C. R, Barrett L.C..: "Advanced Engineering Mathematics" McGraw Hill Book Co., New York, 6th Ed., 2017.

4. Ramana B.V.: "Higher Engineering Mathematics", Tata McGraw-Hill Publishing Company Limited, 1st Ed., 2006.

5. Pal S. & Bhunia S. C.: "Engineering Mathematics" Oxford University Press, 3rd Ed., 2016.

6. Hwei. P Hsu, Signals and Systems, Tata McGraw Hill, Third edition, 2010

7. Simon Haykin and Barry Van Veen, Signals and Systems, John Wiley and Sons, 2nd Ed., 2004.

8. V. Krishnaveni and A. Rajeshwari, Signals and Systems, Wiley-India, 1st Ed., 2012.

9. Michael J Roberts, Fundamentals of Signals and systems, Tata McGraw Hill, special Indian Economy edition, 2009.

Online References:

Sr. No.	Website Name
1.	https://archive.nptel.ac.in/courses/111/106/111106139/
2.	https://www.youtube.com/watch?v=LGxE_yZYigI
3.	https://www.youtube.com/watch?v=lkAvgVUvYvY
4.	https://www.youtube.com/watch?v=sMYtHaSIXbU
5.	https://www.youtube.com/watch?v=XfmbrUBrs5Q

Assessment:

Term work (TW) for 25 marks:

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per the university pattern for practical.
2. Students must be encouraged to write **at least 10** class tutorials on entire syllabus.
3. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project.

This project should be graded for 10 marks depending on the performance of the students.

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The distribution of Term Work marks will be as follows –

1. Regularity and active involvement (Theory and Tutorial) 05 marks.

2. Class Tutorials on entire syllabus 10 marks.

3. Mini Project 10 marks.

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Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					
		L	T	P	L	T	P	SL	Notional Learning Hour	Total Credits (C) (Notional Learning Hour/30)
14211302	Electronic Devices and Linear Circuits	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
14211302	Electronic Devices and Linear Circuits	20	20	40	60	2.5	--	--	100

Rationale :

This syllabus is designed to provide a comprehensive foundation in analog electronic circuits, focusing on the behavior, analysis, and application of BJTs, MOSFETs, operational amplifiers, IC 555 timers, and voltage regulators. It aims to build both theoretical understanding and

practical design skills essential for careers in electronics, embedded systems, and instrumentation.This syllabus is designed to provide a comprehensive foundation in analog electronic circuits, focusing on the behavior, analysis, and application of BJTs, MOSFETs, operational amplifiers, IC 555 timers, and voltage regulators. It aims to build both theoretical understanding and practical design skills essential for careers in electronics, embedded systems, and instrumentation.This syllabus bridges academic fundamentals with practical applications, preparing students for higher studies, competitive exams, and industry roles in electronics design and development.

Course Objectives:

1.To explain functionality of different electronic devices.
2.To perform DC and AC analysis of small signal amplifier circuits.
3.To explain working of differential amplifiers and its applications in operational amplifiers.
4.To understand the concept working principles of Linear Integrated Circuits.
5.To Perform analysis of Linear Integrated Circuits.
6.To design circuits and systems for particular applications using Linear Integrated Circuits.

Course Outcomes:

After successful completion of the course student will be able to

1. Explain working of various electronics devices.
2. Derive expressions for performance parameters of BJT and MOSFET circuits.
3. Understand the fundamentals and areas of applications for the Integrated circuits.
4. Develop the ability to design Linear and Non-Linear application of Integrated Circuits.
5. Cultivate the skill of designing Timer circuits.
6. Gain the skill to design Voltage regulators using Integrated Circuits.

Prerequisite:

1. Engineering Physics-I
2. Engineering Physics-II
3. Basic Electrical Engineering

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite**	Introduction of Diode, BJT, JFET, MOSFET	01	CO1
I	**Biasing of BJT and MOSFET**	1. Construction, working and characteristics of BJT (CE configuration) and E-MOSFET (CS configuration). 2. Concept of DC load line, Q point and regions of operations, Biasing circuits for BJT (Fixed bias & Voltage divider Bias). 3. DC load line and region of operation for E-MOSFET, Biasing circuits for E-MOSFET (Drain to Gate bias & voltage divider bias).	07	CO1
		Self-learning Topics: Construction, working and characteristics of BJT for i) CB configuration & ii) CC configuration, BJT/MOSFET as switches, heat sink and concept of Thermal runaway, Frequency response of amplifiers	07	
II	**Small Signal Analysis of BJT and MOSFET Amplifier.**	1. Concept of AC load line and Amplification, Small signal analysis (Zi, Zo, Av and Ai) of CE amplifiers using hybrid pi model.	07	CO2

		2. Small signal analysis (Zi, Zo, Av) of CS (for E-MOSFET) amplifiers. 3. Frequency response of amplifier, Effect of coupling bypass and parasitic capacitor on frequency response. Miller's theorem.		
		Self-learning Topics: Amplifier Classes (Class A, B, AB, C) – Power & Linearity Trade-offs,Case Study on-Amplifiers in IoT, Medical Devices, and Sensors	07	
III	**Introduction to Differential Amplifier and Operational Amplifier.**	1. E-MOSFET Differential Amplifier, Differential and common mode gain, CMRR, differential and common mode input impedance. 2. Block diagram of Op-Amp , Ideal and Practical characteristics of Op-Amp. Open loop and Closed loop configuration of Op-Amp.. 3. Inverting and Non-inverting Amplifier using Op-Amp, Summing Amplifier, Difference Amplifier.	07	CO3
		Self-learning Topics:MOSFET current mirror and diff pair biasing, Instrumentation Amplifier using Op-Amps,Active Filters Using Op-Amps (LPF, HPF, BPF), Phase Margin, Stability, and Compensation in Op-Amps, Op-Amp as Comparator: Zero-Crossing and Threshold Detection, Real-World Case Study: Op-Amps in ECG or Sensor Front Ends	07	

IV	**Linear and Non-Linear Applications of Operational Amplifier**	1. Integrator & differentiator (ideal & practical), Active Filters: First and Second order active low pass, high pass. 2. Comparators: Inverting comparator, non-inverting comparator. Schmitt Triggers: Inverting Schmitt trigger, non-inverting Schmitt trigger. 3. Positive feedback, Barkhausen's criteria, Sine Wave Oscillators: RC phase shift oscillator, Wien bridge oscillator.	09	CO4
		Self-learning Topics: Op-Amp Based Square Wave and Triangle Wave Generators, Activity: Simulate a square-to-triangle wave generator using op-amps (TinkerCAD/Proteus), Precision Rectifiers (Super Diodes) Using Op-Amps, Butterworth vs. Chebyshev Filter Characteristics, effect of filter order on frequency response, Hysteresis and noise immunity in Schmitt triggers	08	
V	**Timer IC555 and its applications.**	1. IC 555 Timer: Block Schematic, Functional Diagram, Working of IC 555. 2. Design of Monostable and Astable multivibrator using IC 555. 3. Applications of astable and monostable multivibrators as Pulse Width Modulator and Pulse Position Modulator.	07	CO5
		Self-learning Topics: Design of Duty Cycle Controlled Oscillator Using 555 Timer ,555 Timer as a Frequency Divider and Missing Pulse Detector, 555 Timer as Pulse Width Modulator for LED Dimming and Motor Control	08	

VI	**Voltage Regulators.**	1. Block diagram of regulated DC power supply. Functional block diagram, working and design of three terminal fixed voltage regulators (78XX, 79XX series). 2. Functional block diagram, working and design of general-purpose IC 723 (HVLC and HVHC). 3. Design of regulator using three terminal IC LM 317.	07	CO6
		Self-learning Topics: Line and Load Regulation in Power Supplies, Comparison of Switching vs. Linear Regulators, Designing Dual Polarity Power Supplies (+V and –V), Adjustable Regulated Power Supply with Variable Output and Current Limit, Ripple rejection & capacitor selection	08	

Text Books:

1.Donald A. Neamen, "Electronic Circuit Analysis and Design", Tata McGraw Hill, 2nd Edition
2.D. Roy Choudhury and S. B. Jain, "Linear Integrated Circuits", New Age International Publishers, 4th Edition.
3.Ramakant A. Gaikwad, "Op-Amps and Linear Integrated Circuits", Pearson Prentice Hall, 4th Edition

References:

1.S. Salivahanan, N. Suresh Kumar, "Electronic Devices and Circuits", Tata Mc-Graw Hill, 3rd Edition
2.Boylestad and Nashelesky, " Electronic Devices and Circuits Theory", Pearson Education,11th Edition
3.A.K. Maini, "Electronic Devices and Circuits", Wiley
4.K.R. Botkar, "Integrated Circuits", Khanna Publisher (2004)
5.David A. Bell, "Operational Amplifiers and Linear Integrated Circuits", Oxford University Press, Indian Edition.

Online References:

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Sr. No.	Website Name
1.	NPTEL/ Swayam Course: Course: Integrated Circuits and Applications By Prof. Shaik Rafi Ahamed (IIT Guwahati) https://onlinecourses.nptel.ac.in/noc25_ee43/preview
2.	Course: ICs MOSFETs Op-Amps & Their Applications By Prof. Hardik Jeetendra Pandya (IISc Bangalore); https://swayam.gov.in/nd1_noc20_ee13/preview

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Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					
		L	T	P	L	T	P	SL	Notional Learning Hour	Total Credits (C) (Notional Learning Hour/30)
14211303	Network Theory and Control System	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT -1	IAT -2	Total					
14211303	Network Theory and Control System	20	20	40	60	2.5	--	--	100

Rationale:

The integration of Network Theory with Control System concepts equips students with a solid foundation for analyzing and designing complex electrical and control systems. This course bridges theoretical understanding and practical analysis of circuits in both time and frequency domains. It emphasizes the application of network theorems, synthesis techniques, and modelling methods essential for real-world systems. The focus on stability—through time and frequency analysis—builds crucial skills for designing reliable control systems. Understanding two-port networks and transfer functions prepares students for advanced communication and automation systems. The curriculum aligns with engineering problem-solving requirements. Overall, the course develops analytical, design, and diagnostic skills fundamental to electronics and telecommunication engineering.

Course Objectives:

1. To evaluate the Circuits using network theorems, study network Topology, network Functions and two port networks.
2. To analyze the Circuits in time and frequency domain.
3. To synthesize passive networks by various methods.
4. To analyze fundamental concepts of mathematical modelling, time response and Frequency response.
5. To develop concepts of stability and its assessment criteria in the time domain.
6. To develop concepts of stability and its assessment criteria in the frequency domain.

Course Outcomes:

On successful completion of the course student will be able to:

1. Evaluate circuits using network theorems.
2. Apply the time and frequency method of analysis.
3. Analyze the network function and find the various parameters of two port networks.
4. Analyze the response and determine the transfer function of Control System
5. Understand the analysis of systems in the time domain and predict stability of a given system using appropriate criteria.
6. Understand the analysis of systems in frequency domain and predict stability of a given system using appropriate criteria.

Prerequisite:

Knowledge of Basic Electrical Engineering, Engineering Mathematics II

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Electrical Circuit Analysis**	Analysis of Circuits with dependent sources using generalized loop and node analysis, super mesh and super node analysis technique Network Theorems with dependent sources: Superposition, Thevenin's, Norton's and Maximum Power Transfer Theorems (Use only DC source)	**04**	CO1

		Self-learning Topics: Students should understand the four types of dependent sources and their roles in circuits. They must learn generalized nodal and mesh analysis techniques involving these sources. Super node and super mesh methods help simplify circuit analysis. Applying network theorems with dependent sources is crucial for solving DC circuits. Using simulation tools like LTspice enhances practical understanding and verification.	**04**	
II	**Time and frequency domain analysis**	Time domain analysis of R-L and R-C Circuits: Forced and natural response, initial and final values. Solution using first order and second order differential equation with step signals. Frequency domain analysis of R-L-C Circuits: Forced and natural response, effect of damping factor. Solution using second order equation for step signal.	**08**	CO2
		Self-learning Topics: Students should learn the concepts of forced and natural responses in R-L and R-C circuits to understand how systems react to inputs over time. They should study how to determine initial and final values using basic circuit laws and theorems. Mastery of solving first and second-order differential equations is essential for analyzing step response in the time domain. In the frequency domain, understanding R-L-C circuit behaviour, damping effects, and resonance is important. Applying Laplace Transform techniques and analyzing second-order system responses are key to mastering both domains.	**08**	
III	**Network functions and Two Port Networks**	Network functions for the one port and two port networks, driving point and transfer functions, Poles and Zeros of Network functions. Two Port Parameters: Open Circuits, short Circuit, Transmission and Hybrid parameters, relationship among parameters, conditions for reciprocity and symmetry.	**06**	CO3
		Self-learning Topics: Students should understand network functions for one-port and two-port systems, focusing on driving point and transfer functions. They need to learn the significance of poles and zeros and how they influence system behaviour. Exploring various two-port	**06**	

		parameters—such as open circuit, short circuit, transmission, and hybrid—is essential. Understanding the mathematical relationships between these parameters enhances analytical skills. Students should also study the conditions for reciprocity and symmetry to evaluate system characteristics effectively.		
IV	**Analysis and response of control system**	Open and closed loop systems, Transfer function modelling (Electrical only), Block diagram reduction techniques and Signal flow graph. Dynamic Response: Standard test signals, transient and steady state behaviour of first and second order systems, steady state errors in feedback control systems and their types.	**08**	CO4
		Self-learning Topics: Students should begin by understanding the differences between open and closed loop systems and how to model them using transfer functions for electrical systems. Learning block diagram reduction techniques and signal flow graphs helps simplify complex system representations. They should study the dynamic response of first and second-order systems to standard test signals. Understanding both transient and steady-state behaviours is key to system performance analysis. Additionally, students must explore steady-state errors in feedback systems and classify their types for accuracy evaluation.	**08**	
V	**Stability Analysis in Time Domain**	Concept of stability: Routh and Hurwitz stability criterion. Root locus Analysis: Root locus concept, general rules for constructing root-locus, root locus analysis of control system.	**09**	
		Self-learning Topics: Students should understand the fundamental concept of system stability and its importance in control system analysis. Learning the Routh-Hurwitz stability criterion is essential for determining system stability in the time domain. They should explore the root locus method, including its basic principles and significance in control design. Mastering the rules for constructing root locus plots helps visualize how pole locations change with varying system parameters. Applying root locus	**09**	

		analysis enables prediction and improvement of system behaviour and stability.		
VI	**Stability Analysis in Frequency Domain**	Frequency domain specification, Relationship between time and frequency domain specification of system, stability margins. Bode Plot: Magnitude and phase plot, Method of plotting Bode plot, Stability margins and analysis using Bode plot. Concept of Polar plot.	**10**	CO6
		Self-learning Topics: Students should study frequency domain specifications and understand how they relate to time domain performance of a system. Learning stability margins such as gain and phase margins is crucial for assessing system robustness. They should explore how to construct and interpret Bode plots, including both magnitude and phase plots. Analyzing system stability using Bode plots provides insight into frequency response behaviour. Additionally, understanding the concept and application of polar plots further enhances frequency domain analysis skills.	**10**	

Text Books:

1. Franklin F Kuo, “Network Analysis and Synthesis”, Wiley Toppan, 2 nd ed. ,1966.
2. M E Van Valkenburg, “Network Analysis”, Prentice-Hall of India Pvt Ltd, New Delhi, 26th Indian Reprint, 2000.
3. Nagrath, M.Gopal, “Control System Engineering”, Tata McGrawHill.

References:

1. A. Chakrabarti, “Circuit Theory”, Dhanpat Rai & Co., Delhi, 6th Edition.
2. A. Sudhakar, Shyammohan S. Palli “Circuits and Networks”, Tata McGraw-Hill education.
3. Smarajit Ghosh “Network Theory Analysis & Synthesis”, PHI learning.
4. K.S. Suresh Kumar, “Electric Circuit Analysis” Pearson, 2013.
5. D. Roy Choudhury, “Networks and Systems” , New Age International, 1998.
6. Rangan C. S., Sarma G. R. and Mani V. S. V., "Instrumentation Devices And Systems", Tata McGraw-Hill, 2nd Ed.,2004.
7. K.Ogata, “Modern Control Engineering, Pearson Education”, IIIrd edition.

Sr. No.	**NPTEL / Swayam Course**
1.	Course: Basic Electrical Circuits by Prof. Nagendra Krishnapura (IIT Madras); https://swayam.gov.in/nd1_noc20_ee64/preview.
2.	Course: Control Systems by Prof. C. S. Shankar Ram (IIT Madras); https://swayam.gov.in/nd1_noc20_ee90/preview

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					
		L	T	P	L	T	P	SL	Notional Learning Hour	Total Credits (C) (Notional Learning Hour/30)
14211304	Digital System Design	3	–	--	45		--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
14211304	Digital System Design	20	20	40	60	2.5	--	--	100

Rationale :

Digital System Design is a foundational subject that equips students with the knowledge and skills to design and implement digital circuits and systems. It emphasizes the use of logic gates, combinational and sequential circuits, finite state machines, and hardware description languages like VHDL or Verilog. This course is essential for developing efficient digital architectures in fields such as embedded systems, computer architecture, and communication systems, thereby preparing students for careers in hardware design and electronics.

Course Objectives:

1. To understand number system representations and their inter-conversions used in digital electronic circuits.
2. To understand the functionalities, and Characteristics of Logic Families and Minimization techniques to realise logical operations.
3. To analyze digital logic processes and to implement logical operations using various combinational logic circuits.
4. To analyze, design and implement the logical operations using different sequential logic circuits.
5. To equip students with the knowledge and skills to design, and implement various registers, counters, and programmable logic devices.
6. To get acquainted with the basics of VHDL language.

Course Outcomes:

On successful completion of the course student will be able to:

1. Apply the concepts of number systems and perform code conversions.
2. Classify logic families, Understand Digital circuits and apply minimization techniques to implement logical functions.
3. Analyze, design and implement combinational logic circuits.
4. Analyze, design and implement sequential logic circuits.
5. Analyze, design and implement digital circuits using different registers, counters, and programmable logic devices.
6. Apply VHDL & appropriate EDA tool for logic design and simulation using VHDL/Verilog.

Prerequisite:

Basic Electrical Engineering

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Number Systems and Codes**	Review of Binary, Octal and Hexadecimal Number Systems, their inter-conversion, Gray code and BCD code, Binary Addition, Subtraction using 1's and 2's Complement method.	**04**	CO1

		Self-learning Topics: Gray Code: Applications in error correction and rotary encoders.Excess-3 (XS-3) Code: Used in BCD arithmetic and digital clocks.Reflected Binary Codes: Role in digital communication systems.Parity Bits (Even/Odd).	**04**	
II	**Logic families and Minimization Techniques**	Classification of logic families: Unipolar and Bipolar Logic Families, Characteristics of Digital ICs, TTL and CMOS comparison. Digital logic gates, Universal gates, Realization using NAND and NOR gates, Boolean Algebra, De Morgan's Theorem. Minimization of Boolean expressions :- SOP, POS, Quine-McCluskey minimization method and Karnaugh map (up to 4 variables)	**10**	CO2
		Self-learning Topics: Advanced Characteristics Comparison :Deep comparison: TTL, CMOS, ECL, BiCMOS, RTL, DTL,Analyze parameters: speed, fan-out, fan-in, power, noise margin, Use case examples in modern circuits. Petrick's Method :Used when multiple minimal solutions exist,Manual walkthrough with a solved example,Compare with Quine-McCluskey	**10**	
III	**Combinational Logic Circuits**	Adder (half and full), Subtractor (half and full), Multiplexer, Demultiplexer, Code Converter, BCD adder, Magnitude Comparator, Parallel Adder, Implementation of Logic expressions using Multiplexers, De-multiplexers, Encoders and Decoders.	**10**	CO3
		Self-learning Topics: Implementation of Boolean Functions Using Multiplexers & Decoders, Realizing any logic function using 4:1 or 8:1 MUX, Implementing functions using decoders and external gates, Application:Use MUX to build a simple ALU block. Carry Look-Ahead Adder (CLA): Principle and implementation.	**10**	

IV	**Sequential Logic Circuits**	Flip flops (FF): SR, JK, T, D, Master Slave JK flip flops, Truth table, excitation table,triggering methods, and flip flop conversions. Counters: Asynchronous and Synchronous - MOD N, UP/DOWN, Decade counter, Frequency division, Finite State Machine: Introduction to Moore and Mealy machines - Block diagram, state diagram, state tables.	**10**	CO4
		Self-learning Topics: Causes of glitches in sequential circuits, Clock domain crossing (CDC) issues, Use of synchronizer circuits (2-flip-flop sync), Sequence detection using Mealy and Moore FSMs, Optimization of state diagrams, Shift Registers and Applications: Ring counter, twisted ring counter,Use in data serialization, delay lines, and counters, Issues with asynchronous vs synchronous shifting.	**10**	
V	**Shift Registers and Programmable Logic Devices**	Registers: SISO, SIPO, PISO, PIPO, Universal Shift registers, Ring counter, Johnson counter, Sequence generator. Structure of Programmable Logic Devices (PLDs), Function implementation with Programmable Logic Array (PLA) and Programmable Array Logic (PAL). Introduction to CPLD and FPGA.	**06**	
		Self-learning Topics: Advanced Types of Shift Registers :Bidirectional , Use cases in digital delay, waveform generation, Serial-to-parallel and parallel-to-serial data converters, Sequence generators using feedback logic, Use of master clocking and avoiding timing faults	**06**	
VI	**Introduction to VHDL**	VLSI Design flow (Frontend): Design entry: Schematic different modeling styles in VHDL, Data types and objects, Synthesis and Simulation, implementation of combinational and sequential logic using VHDL.	**05**	CO6

		Self-learning Topics: Advanced VHDL Data Types & Operators: typecasting and arithmetic with custom types, ,Overloaded operators and type conversion, Behavioral Modeling with Processes & Wait Statements,Sensitivity lists and event-driven modeling, Writing effective testbenches (stimulus generation)	**05**	

Text Books:

1. R.P. Jain, "Modern Digital Electronics", Tata McGraw Hill Publication, 4th Edition.
2. Morris Mano, Michael D. Ciletti, "Digital Design", Pearson Education, Fifth Edition
3. A. Anand Kumar, "Fundamentals of Digital Circuits", PHI, Fourth Edition (2016).
4. J. Bhaskar A Verilog HDL Primer , Third Edition, Star Galaxy publishing
5. Sameer Palnitkar "Verilog HDL, A guide to digital
6. Douglas Perry, "VHDL programming", McGraw Hill, fourth edition.

References:

1. John F. Warkerly, "Digital Design Principles and Practices", Pearson Education,Fifth Edition (2018).
2. Digital fundamentals by FLOYD & JAIN, Pearsons Pub
3. Charles Roth, "Digital System Design using VHDL", Tata McGraw Hill

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					
		L	T	P	L	T	P	SL	Notional Learning Hour	Total Credits (C) (Notional Learning Hour/30
14212305	Analog & Digital Circuits Lab	--	--	2	--	--	30	--	30	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical / Oral	Total
		Internal assessment			End Sem. Exam			
		IAT I	IAT II	Total				
14212305	Analog & Digital Circuits Lab	--	--	--	--	25	25	50

Lab Objectives:

1. Understand and verify the truth tables of basic logic gates and their applications
2. Design and implement combinational logic circuits (adders, subtractors, multiplexers, decoders)
3. Construct sequential logic circuits such as flip flops, counters, registers and transfer function of system.
4. Generate and process sinusoidal and non-sinusoidal signals (e.g., wave shaping, filters)
5. Analyze and design various multivibrator circuits (astable, monostable, bistable)
6. Use transistors and op amps for switching, amplification, waveform generation, and signal conditioning

Lab Outcomes:

1. Students will be proficient in testing and applying basic logic gates in digital circuit designs

2. Students will develop skills to design and validate combinational logic systems like adders and multiplexers
3. Students will be competent in implementing and analyzing sequential circuits including counters, registers and transfer function of the system.
4. Students will be able to generate, shape, filter, and analyze analog waveforms using RC and op-amp circuits
5. Students will gain ability to design, build, and troubleshoot multivibrator circuits for timing and pulse generation
6. Students will be prepared to apply circuit design and analysis techniques essential for advanced electronics and embedded systems

List of Experiments.

Sr No	List of Experiments	Hrs
01	Implement AND, OR, NOT, EXOR, EX-NOR gates using Universal gates NAND and NOR.	2
02	Flip-flop conversions JK to D, JK to T and D to T FF.	2
03	Study of Universal Shift Register using IC-74194.	2
04	Design a Ring/ Johnson's counter using IC-74194.	2
05	Implement adder circuits using VHDL/Verilog	2
06	Design a Multiplexer using VHDL/Verilog	2
07	Design asynchronous/synchronous MOD N counter using IC7490	2
08	Design and implement Magnitude Comparator.	2
09	To study BJT biasing Circuits.	2
10	To Study BJT as a CE amplifier.	2

11	To study EMOSFET biasing circuits	2
12	To study EMOSFET as a CS amplifier.	2
13	Simulations Experiment on study of Frequency Response of CS amplifier.	2
14	Simulations Experiment on study of Differential amplifier	2
17	Design and analyze Integrator circuits using OPAMP.	2
18	Design and analyze Differentiator circuits using OP AMP.	2
19	Design and analyze RC phase shift Oscillator.	2
20	Design and analyze first order High pass and Low pass filters.	2
21	Design of Monostable Multivibrator Circuit using 555 Timer	2
22	Design of Astable Multivibrator Circuit using 555 Timer	2
23	To Study basics of scilab and plot basic input signal for control system	2
24	To evaluate Routh criterion using SCILAB for given transfer function	2
25	To plot root locus using SCILAB for given transfer function	2
26	To Construct Polat Plot using SCILAB for given transfer function	2
27	To Construct Bode Plot using SCILAB for given transfer function	2

Sr. No.	**List of Assignments / Tutorials**	**Hrs.**
01	Number Systems and Interconversions, Binary Codes.	01
02	Boolean Algebra and Minimization using K-Map.	01
03	Biasing of BJT and MOSFET	01

04	Small Signal Analysis of BJT and MOSFET Amplifier.	01
05	Voltage Regulators.	01

Online Resources:

Sr. No.	Website Name
1.	https://archive.nptel.ac.in/courses/108/105/108105158/

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practicals' based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

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Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					
		L	T	P	L	T	P	SL	Notional Learning Hour	Total Credits (C) (Notional Learning Hour/30
14212306	Skill Lab-Java Programming	--	--	2	--	--	30	--	30	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT 1	IAT 2	Total				
14212306	Skill Lab-Java Programming	--	--	--	--	25	25	50

Prerequisite: C and C++ Programming

Lab Objectives:

1 To understand the concepts of object-oriented paradigm in the Java programming language.
2 To understand the importance of Classes & objects along with control structures, Arrays ,Strings, vectors, functions and constructors.
3 To learn and implement the principles of inheritance, polymorphism and operator overloading in Java for better software design.

4 To implement the concepts of file handling, memory management and packages in Java
5 To recognize usage of Exception Handling, Multithreading in various applications using Java.
6 To familiarize students with advanced Java concepts like GUI programming, and applet development.

Lab Outcomes:

1) Explain the fundamental concepts of Java Programming.
2) Use the concepts of classes, objects, members of a class and the relationships among them needed for finding the solution to a specific problem.
3) Demonstrate how to extend java classes and achieve reusability using Inheritance, Polymorphism and Operator Overloading.
4) Apply the concept of file handling and memory management to find fast solutions for various problems using Java programming.
5) Construct robust and faster programmed solutions to problems using the concept of Multithreading, exceptions.
6) Design and develop Graphical User Interface and Applets to develop real time applications.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite			
I	Java Fundamentals	Overview of procedure and object oriented Programming, Java Designing Goals and Features of Java Language. Introduction to the principles of object-oriented programming: Classes, Objects, Abstraction, Encapsulation, Inheritance, Polymorphism. Keywords, Data types, Variables, Operators,	07	CO1

		Expressions, Types of variables and methods. Control Statements: If Statement, If-else, Nested if, switch Statement, break, continue. Iteration Statements: for loop, while loop, and do-while loop.		
II	Classes, objects, Arrays and Strings	Classes & Objects: Reference Variables, Passing parameters to Methods and Returning parameters from the methods, Static members, Non-Static members Nested and Inner Classes. Static Initialization Block (SIB), Instance Initialization Block(IIB) Constructors: Parameterized Constructors, chaining of constructor, finalize() Method, Method overloading, Constructors Overloading. Recursion, Command -Line Arguments. Wrapper classes, InputBufferReader, Output Buffer Reader, String Buffer classes, String functions. Arrays & Vectors: One and Two Dimensional arrays, Irregular arrays, dynamic arrays, Array List and Array of Object.	08	CO2
III	Inheritance, Polymorphism and Operator Overloading	Inheritance: Inheritance Basics, Types of Inheritance in Java, member access, using Super- to call superclass Constructor, to access member of super class(variables and methods), creating multilevel hierarchy, Constructors in inheritance, method overriding, Abstract classes and methods, using final, Dynamic Method Dispatch	06	CO3

IV	Exception Handling, Multithreading,	Exception Handling: Exception -Handling Fundamentals, Exception Types, Exception class Hierarchy, Using try and catch, Multiple catch Clauses, Nested try Statements, throw, throws, finally , Java's Built-in Exceptions, Creating Your Own Exception Subclasses. Multithreaded Programming: The Java Thread Model and Thread Life Cycle, Thread Priorities, Creating a Thread, Implementing Runnable, Extending Thread, Creating Multiple Threads, Synchronization: Using Synchronized Methods.	06	CO4
V	File Handling, Memory Management and Packages	I/O Streams: Streams, Byte Streams and Character, The Predefined Streams, Reading Console Input, Reading Characters, Reading Strings, Writing Console Output, Reading and Writing Files.	06	CO5
VI	GUI programming and Applets	Designing Graphical User Interfaces in Java: Components and Containers, Basics of Components, Using Containers, Layout Managers, AWT Components, Adding a Menu to Window, Extending GUI Features	06	CO6

Suggested List of Experiments:

Sr No	List of Experiments	Hrs
	NOTE: Perform any 2 programs from each module	
01	1) Implement a java program to calculate gross salary & net salary using the following data. Input: empno, empname, basic Process: DA=70% of basic, HRA=30% of basic , CCA=Rs240/- , PF=10% of basic ,PT= Rs100/- 2) Five Bikers Compete in a race such that they drive at a constant speed which may or may not be the same as the other. To qualify the race, the speed of a racer must be more than the average speed of all 5 racers. Write a Java program to take as input the speed of each racer and print back the speed of qualifying racers. 3) Write a Java program that prints all real solutions to the quadratic equation ax2+bx+c = 0. Read in a, b, c and use the quadratic formula. If the discriminant b2-4ac is negative, display a message stating that there are no real solutions? 4) Write a Menu driven program in java to implement a simple banking application. Application should read the customer name, account number, initial balance,rate of interest, contact number and address field etc. Application should have following methods. 1. createAccount() 2. deposit() 3. withdraw() 4. computeInterest() 5. displayBalance() 5)Write a menu driven Java program which will read a number and should implement the following methods 1. factorial() 2. testArmstrong()	2

	3. testPalindrome() 4. testPrime() 5. fibonacciSeries() Create a Java based application to perform various ways of Method overloading.	
02	1) Write a program that would print the information (name, year of joining, salary, address) of three employees by creating a class named 'Employee'. The output should be as follows: 2) Write a program to print the area of a rectangle by creating a class named 'Area' having two methods. First method named as 'setDim' takes length and breadth of the rectangle as parameters and the second method named as 'getArea' returns the area of the rectangle. Length and breadth of rectangle are entered through the keyboard. 3) Write a Java program to illustrate Constructor Chaining. 4) Create a class 'Student' with three data members which are name, age and address. The constructor of the class assigns default values name as "unknown", age as '0' and address as "not available". It has two members with the same name 'setInfo'. First method has two parameters for name and age and assigns the same whereas the second method has three parameters which are assigned to name, age and address respectively. Print the name, age and address of 10 students. Hint - Use an array of objects. 5) Write a java programs to add n strings in a vector array. Input new string and check whether it is present in the vector. If it is present delete it otherwise add it to the vector. 6) Print the sum, difference and product of two complex numbers by creating a class named 'Complex' with separate methods for each operation whose real and imaginary parts are entered by the user. 7)Write menu driven program to implement recursive Functions for following tasks. a) To find GCD and LCM b) To print n Fibonacci numbers	2

	c) To find reverse of number d) To solve 1 +2+3+4+.....+(n- l)+n 8) Print Reverse Array list in java by writing our own function.	
03	1) Create a Teacher class and derive Professor / Associate_Professor /Assistant_Professor class from Teacher class. Define appropriate constructors for all the classes. Also define a method to display information about the Teacher. Make necessary assumptions as required. 2) Create a class Book and define a display method to display book information. Inherit Reference_Book and Magazine classes from Book class and override display method of Book class in Reference_Book and Magazine classes. Make necessary assumptions required. 3) A university has two types of students — graduate students and research students. The University maintains the record of name, age and programme of every student. For graduate students, additional information like percentage of marks and stream, like science, commerce, etc. is recorded; whereas for research students, additionally, specialization and years of working experience, if any, is recorded. Each class has a constructor. The constructor of subclasses makes a call to the constructor of the superclass. Assume that every constructor has the same number of parameters as the number of instance variables. In addition, every subclass has a method that may update the instance variable values of that subclass. All the classes have a function display_student_info( ), the subclasses must override this method of the base class. Every student is either a graduate student or a research student. Perform the following tasks for the description given above using Java : (i) Create the three classes with proper instance variables and methods, with suitable inheritance. (ii) Create at least one parameterised constructor for each class. (iii) Implement the display_student_info( ) method in each class. 4) An employee works in a particular department of an organization. Every employee has an employee number, name and draws a particular salary. Every department has a name and a head of department. The head of the department	2

	is an employee. Every year a new head of department takes over. Also, every year an employee is given an annual salary enhancement. Identify and design the classes for the above description with suitable instance variables and methods. The classes should be such that they implement information hiding. You must give logic in support of your design. Also create two objects of each class. 5) Consider a hierarchy, where a sportsperson can either be an athlete or a hockey player. Every sportsperson has a unique name. An athlete is characterized by the event in which he/she participates; whereas a hockey player is characterised by the number of goals scored by him/her. Perform the following tasks using Java : (i)Create the class hierarchy with suitable instance variables and methods. (ii) Create a suitable constructor for each class. (iii) Create a method named display_all_info with suitable parameters. This method should display all the information about the object of a class. (iv) Write the main method that demonstrates polymorphism. 6) Create an interface vehicle and classes like bicycle, car, bike etc, having common functionalities and put all the common functionalities in the interface. Classes like Bicycle, Bike, car etc implement all these functionalities in their own class in their own way. 7) Create a class "Amount In Words" within a user defined package to convert the amount into words. (Consider the amount not to be more than 100000).	
04	1) Write a java program where the user will enter login id and password as input. The password should be 8 digits containing one digit and one special symbol. If the user enters a valid password satisfying above criteria then show “Login Successful Message”. If a user enters an invalid Password then create InvalidPasswordException stating Please enter valid password of length 8 containing one digit and one Special Symbol. 2) Java Program to Create Account with 1000 Rs Minimum Balance, Deposit Amount, Withdraw Amount and Also Throws LessBalanceException. It has a Class Called LessBalanceException Which returns the Statement that Says WithDraw Amount(_Rs) is Not Valid. It has a Class Which Creates 2 Accounts, Both Account Deposit Money and One Account Tries to	2

	WithDraw more Money Which Generates a LessBalanceException Take appropriate Action for the Same. 3) Create two threads such that one thread will print an even number and another will print an odd number in an ordered fashion. 4) Assume that two brothers, Joe and John, share a common bank account. They both can, independently, read the balance, make a deposit, and withdraw some money. Implementing a java application demonstrates how the transaction in a bank can be carried out concurrently. 5) You have been given the list of the names of the files in a directory. You have to select Java files from them. A file is a Java file if it's name ends with ".java". For e.g. File- "Names.java" is a Java file, "FileNames.java.pdf" is not. Input: test.java, ABC.doc, Demo.pdf, add.java, factorial.java, sum.txt Output: tset.java, add.java, factorial.java	
05	**1)Reading Characters from Console** Program to read single characters using `InputStreamReader` and `BufferedReader`. **2)Reading Strings from Console** Program to read full strings using `BufferedReader` and display the input. **3)Writing Output to Console** Use `System.out.println` and `PrintWriter` to display various types of output. **4)Reading and Writing Text Files (Character Streams)** Program using `FileReader` and `FileWriter` to read from one text file and write to another. **5)Copying Binary Files using Byte Streams** Program to copy an image or video file using `FileInputStream` and `FileOutputStream`.	2

	6)Counting Characters, Words, and Lines in a File Read a text file and count the number of characters, words, and lines using `BufferedReader`. **7)Appending Data to a Text File** Use `FileWriter` in append mode to add content to an existing file. **8)Creating a File and Writing User Input to It** Read input from the console and write it to a new file using character streams. **9)Read from File and Display Content with Line Numbers** Read a file and print its contents on the console with line numbers prepended.	
06	**1)Creating a Basic AWT Window** Write a program to create a basic window using Frame, Label, and Button. **2)Using Different Layout Managers** Implement programs using FlowLayout, BorderLayout, and GridLayout to arrange GUI components. **3)Building a Simple Form with Text Fields** Design a user registration/login form using Label, TextField, Checkbox, and Button. **4)Handling Events on Buttons and TextFields** Write a program to perform addition or string concatenation based on button clicks. **5)Creating a Menu Bar and Menu Items** Design a GUI with a MenuBar, multiple Menu and MenuItem, with action listeners for each item.	2

Text Books:

1. Herbert Schildt, "Java-The Complete Reference", Tenth Edition, Oracle Press, Tata McGraw Hill Education.
2. E. Balguruswamy, "Programming with Java A primer", Fifth edition, Tata McGraw Hill Publication
3. Anita Seth, B.L.Juneja, " Java One Step Ahead", oxford university press.

References:

1. D.T. Editorial Services, "Java 8 Programming Black Book", Dreamtech Press.
2. Learn to Master Java by Star EDU Solutions
3. Yashvant Kanetkar, "Let Us Java" ,4th Edition ,BPB Publications.

Online References:

Sr. No.	Website Name
1.	https://www.w3schools.com/java/
2.	https://www.geeksforgeeks.org/java/
3.	https://docs.oracle.com/javase/tutorial/
4.	https://www.javatpoint.com/java-tutorial

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practicals' based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical& Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

R-2025- All Branches

Course Code	Course Name	Teaching Scheme (Contact Hours)			Teaching Scheme (Contact Hours Per Semester)					Total
		L	T	P	L	T	P	SL	Notional Learning Hour	
9951137WW	Open Elective	2	-	-	30	-	-	30	60	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
9951137WW	Open Elective	--	--	--	--	--	25	--	25

Students must select a course for Open Elective from a bucket provided by the Rahul Education Group.

Term Work Assessment: 25 Marks (Total marks) = 15 Marks (Case Study/Activity) + 5 Marks (Assignments) + 5 Marks (Attendance)

Shree L. R. Tiwari Educational Campus, Mira Road (East), Thane- 401 107, Maharashtra.
022-2812 0144 /45 / 43 slrtce@rahuleducation.com www.rahuleducation.com

R-2025- S.E All Branches

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
98431308	Entrepreneurship Development	2	-	-	30		-	30	60	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
98431308	Entrepreneurship Development	--	--	--	--	--	25	--	25

Rationale :

Entrepreneurship is a crucial skill in the 21st century, fostering innovation, self-employment, and economic development. This course is designed to equip students with practical entrepreneurial competencies such as ideation, business model development, financial planning, legal frameworks, and pitching.

Course Objectives:

1. Understand and explain the fundamentals of entrepreneurship and startup ecosystems.
2. Generate, validate, and refine business ideas using structured techniques.
3. Develop comprehensive business plans and financial strategies.

4. Explore legal and funding options for startups in India.
5. Apply marketing, digital tools, and CRM for business growth.
6. Design prototypes and present business pitches to stakeholders.

Course Outcomes:

On successful completion of the course learner will be able to:

1) Explain entrepreneurial concepts and analyze types and traits of entrepreneurs.
2) Apply ideation techniques and validate business ideas using customer discovery tools.
3) Create business plans with financial projections and risk analysis.
4) Evaluate funding sources and legal requirements for a startup.
5) Implement digital marketing and branding strategies effectively.
6) Prepare and deliver compelling business pitches with basic prototyping.

Prerequisite: Fundamentals of communication and leadership skills.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Fundamentals of communication and leadership skills.		
I	**Introduction to Entrepreneurship**	Definition, Characteristics, and Types of Entrepreneurs. Entrepreneurial Motivation and Traits. Start-up Ecosystem in India. Challenges in Entrepreneurship	4	CO1
		Self-learning Topics: Evolution of Indian startup ecosystem post-2010 **Case Study**: Nirma – A middle-class entrepreneur revolutionizing detergents.	4	

R-2025- S.E All Branches

II	**Business Idea Generation & Validation**	Ideation Techniques: Design Thinking, Brainstorming, Mind Mapping. Business Model Canvas (BMC). Market Research & Customer Validation. Minimum Viable Product (MVP) Concept.	5	CO2
		Self-learning Topics: Lean Canvas, Persona Creation **Case Study:** Airbnb – Validating the concept with MVP	5	
III	**Business Planning & Strategy**	Writing a Business Plan. SWOT Analysis and Competitive Analysis. Financial Planning and Budgeting. Risk Assessment and Management.	5	CO3
		Self-learning Topics: Financial forecasting using Excel/Google Sheets. **Case Study:** Zomato – Expansion through mergers & strategic pivots	5	
IV	**Funding and Legal Framework**	Sources of Funding: Bootstrapping, Angel Investors, Venture Capital Government Schemes & Start-up India Initiatives. Business Registration & Legal Formalities. Intellectual Property Rights (IPR) & Patents	6	CO4
		Self-learning Topics: DPIIT recognition process and types of funding **Case Study:Paytm –** From Wallet to IPO: Funding journey	6	

V	**Marketing & Digital Presence**	Branding and Digital Marketing. Social Media Marketing & SEO. Customer Relationship Management (CRM). E-commerce & Online Business Models.	5	CO5
		Self-learning Topics: Use of Canva, Google Analytics **Case Study:** Lenskart – Omnichannel e-commerce marketing	5	
VI	**Business Pitching & Prototype Development**	Pitch Deck Preparation & Presentation Techniques. Prototyping with Open-source Tools. Elevator Pitch & Investor Pitch.	5	CO6
		Self-learning Topics: Canva for pitch deck or Successful Start-ups **Case Study:** Dunzo – MVP to final app evolution	5	
Total			30	

Text Books:

1. "Entrepreneurship Development and Small Business Enterprises" – Poornima M. Charantimath, Pearson, 3rd Edition, 2021.
2. "Innovation and Entrepreneurship" – Peter F. Drucker, Harper Business, Reprint Edition, 2019.
3. "Startup and Entrepreneurship: A Practical Guide" – Rajeev Roy, Oxford University Press, 2022.
4. "Essentials of Entrepreneurship and Small Business Management" – Norman Scarborough, Pearson, 9th Edition, 2021.
5. "The Lean Startup" – Eric Ries, Crown Publishing, 2018.

References:

1. "Disciplined Entrepreneurship: 24 Steps to a Successful Startup" – Bill Aulet, MIT Press, 2017.
2. "Zero to One: Notes on Startups, or How to Build the Future" – Peter Thiel, 2014.
3. "The $100 Startup" – Chris Guillebeau, Crown Business, 2019.
4. "Business Model Generation" – Alexander Osterwalder & Yves Pigneur, Wiley, 2020.
5. "Blue Ocean Strategy" – W. Chan Kim & Renée Mauborgne, Harvard Business Review Press, 2019.

Online References:

Sr. No.	Website Name
1.	Startup India Portal – https://www.startupindia.gov.in
2.	MIT OpenCourseWare – Entrepreneurship – https://ocw.mit.edu/courses/sloan-school-of-management/
3.	Coursera – Entrepreneurship Specialization – https://www.coursera.org/specializations/entrepreneurship

Assessment:

Term Work: Term Work shall consist of at least 4 to 5 **Case Study Analysis , Presentation** based on the above list. Also, Term work Journal must include at least 2 to 3 assignments.
Term Work Marks: 25 Marks (Total marks) = 15 Marks (Case Study report)+ 5 Marks (Assignments) + 5 Marks (Attendance)

R-2025- S.E All Branches

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned					Total Credits (C)
		L	T	P	L	T	P	SL	Notional Learning Hour	(Notional Learning Hour/30
98451309	Environmental Science	2	-	-	30		-	30	60	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
98451309	Environmental Science	20	20	40	60	2.5	--	--	100

Rationale :

Environmental Science provides a multidisciplinary perspective to understand, analyze, and solve ecological challenges. With growing global concern over climate change, pollution, and sustainable development, it is essential to equip students with the knowledge, skills, and values needed to contribute to sustainable solutions.

Course Objectives:

1. To understand the interrelationship between human activities and the environment.
2. To explore natural ecosystems and biodiversity conservation techniques.

3. To identify causes, effects, and mitigation strategies for various types of environmental pollution.
4. To analyze key environmental policies, laws, and sustainability practices.
5. To develop awareness, ethics, and responsibility towards environmental protection.
6. To promote sustainable development through informed decision-making and community participation.

Course Outcomes:

On successful completion of the course learner will be able to:

1) Explain core concepts of environmental science and ecological balance.
2) Identify sources and impacts of pollution on ecosystems and human health
3) Evaluate biodiversity importance and conservation strategies.
4) Analyze climate change, global warming, and their mitigation approaches.
5) Interpret government policies and sustainable practices for environment management.
6) Propose solutions for environmental issues at local and global levels.

Prerequisite: Basic Science Knowledge, General Awareness – About environmental issues, public policies, and civic responsibilities.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic Science Knowledge, General Awareness – About environmental issues, public policies, and civic responsibilities.		
I	**The Multidisciplinary Nature of Environmental Studies**	Definition, scope and importance. Need for public awareness. Role of information technology in environment and human health. Human population and the Environment. Population growth, variation	5	CO1

		among nations. Population Explosion- family welfare program. Environment and human health Women and child welfare.		
		Self-learning Topics: Environmental ethics **Case Study**: Chipko Movement (India) – Grassroot conservation.	5	
II	**Natural Resources**	Renewable and non-renewable resources. Natural resources & associated problems: a. Forest resources: b. Water resources: Natural resources & associated problems c. Mineral resources: d. Food resources: e. Energy resources: Role of an c. Mineral resources: d. Food resources: e. Energy resources: Role of an individual in conservation of natural resources: f. Equitable use of resources for sustainable lifestyles.	5	CO2
		Self-learning Topics: Carbon footprint calculators **Case Study:** Rainwater Harvesting	5	
III	**Ecosystems**	Concepts of an ecosystem. Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem	5	CO3

		b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystem (ponds, streams, lakes, rivers, Oceans, estuaries). Case study on various ecosystems in India.		
		Self-learning Topics: Biodiversity in Indian context **Case Study:** various ecosystems in India.	5	
IV	**Biodiversity and its Conservation**	Introduction-Definition: genetic species and ecosystem diversity. Bio-geographical classification of India Value of biodiversity : Consumptive use, productive use, social, ethical, aesthetic and option values, Bio-diversity at global, national, local levels India as a mega diversity nation Case study on Bio diversity in India.	5	CO4
		Self-learning Topics: Indoor pollution sources	5	
V	**Environmental Pollution Definition**	Causes of Pollution , effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution. Solid waste management: Causes, effect and control measures of urban and industrial wastes. Role of an individual in prevention of pollution.	5	CO5

		Self-learning Topics: Greenhouse gases **Case study:** Pollution Disaster management: floods, earthquake, cyclone and landslides. Carbon Credits for pollution prevention	5	
VI	**Social Issues and Environment**	From unsustainable to sustainable development Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Environmental ethics: issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Consumerism and waste products. Environment protection act. Public awareness.	5	CO6
		Self-learning Topics: Environmental audit methods. **Case Study:** Environmental Ethics.	5	
Total			30	

Text Books:

1. Environmental Science: Towards a Sustainable Future, G. Tyler Miller and Scott Spoolman, 13th Edition, Cengage Learning 2021
2. Environmental Management: Text and Cases, Bala Krishnamoorthy, 3rd Edition, PHI Learning, Publication Year: 2016
3. Green IT: Concepts, Technologies, and Best Practices, Markus Allemann 1.

Springer 2008

4. Sustainable IT: Slimming Down and Greening Up Your IT Infrastructure, David F. Linthicum, IBM Press 2009
5. Environmental Modelling: Finding Solutions to Environmental Problems, David L. Murray, Cambridge University Press 2016
6. Remote Sensing and Image Interpretation, Thomas M. Lillesand, Ralph W. Kiefer, and Jonathan W. Chipman, 9th Edition, John Wiley & Sons 2020
7. Business Ethics: Concepts and Cases, Manuel Velasquez, Pearson 2012

References:

1. Environmental Law and Policy in India, Shyam Divan and Armin Rosencranz, 2nd Edition, Oxford University Press 2018.
2. The International Handbook of Environmental Laws, David Freestone and Jonathon L. Rubin, Edward Elgar Publishing 2000.
3. E-Waste Management: Challenges and Opportunities in Developing Countries, Ruediger Kuehr and Ram K. Jain, Springer 2008.
4. The E-Waste Handbook: Managing Electronic Waste, Klaus Hieronymi, Ruediger Kuehr, and Ram K. Jain, Earth 2009.
5. Environmental Ethics: An Introduction, J. Baird Callicott, University of Georgia Press, 1999.

Online References:

Sr. No.	Website Name
1.	Centre for Science and Environment (CSE), Website: cseindia.org
2.	Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India
3.	CSIR-National Environmental Engineering Research Institute (NEERI)

R-2025- S E Electronics and Telecommunication Engineering

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					
		L	T	P	L	T	P	SL	Notional Learning Hour	Total Credits (C) (Notional Learning Hour/30)
14612310	IDEA LAB -3(Innovation Design Engineering and Apply)	1	--	2	15	--	30	15	60	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT 1	IAT 2	TOTAL				
14612310	IDEA LAB - 3(Innovation Design Engineering and Apply)	--	--	--	--	50	50	100

Rationale :

Aligned with the National Education Policy (NEP) 2020, the institution emphasizes experiential, interdisciplinary, and project-based learning through the IDEA Lab—a central hub for hands-on innovation.

To strengthen the undergraduate research ecosystem, the institution has adopted a theme-based academic model aligned with UN SGD. Each semester features six curated problem statements based on local need and aligned with core subjects in the same semester, enabling students to apply classroom knowledge to real-world challenges. Every student selects one problem and develops an individual, subject-integrated solution—enhancing both academic understanding and research skills.

The IDEA Lab supports this initiative with facilities for design thinking, prototyping, and product development. Students maintain a project logbook throughout the semester to track their progress and reflections.

To ensure academic accountability, a two-tier assessment framework is implemented:

- Project Assessment based on standardized IDEA Lab rubrics.
- Subject-Based Term Work Assessment focused on the application of same-semester subject knowledge in the project.

Lab Objectives:

1. To promote experiential and project-based learning that bridges theoretical knowledge with real-world problem-solving.
2. To encourage interdisciplinary integration by enabling students to apply concepts from multiple subjects within a single cohesive project.
3. To develop innovation and design thinking skills through hands-on activities and iterative solution development.
4. To foster critical thinking and creativity by engaging students in open-ended problems with multiple solution pathways.
5. To enhance communication, collaboration, and documentation skills essential for professional engineering practice.

6. To build an entrepreneurial and research mindset by guiding students to develop scalable, socially-relevant, and technically viable prototype

Lab Outcomes: Student will be able to

1. Recall and articulate key concepts from core and allied subjects relevant to the assigned project.
2. Explain the interdisciplinary nature of the problem and the role of each subject in addressing it.
3. Apply appropriate tools, techniques, and theoretical knowledge to develop project components.
4. Analyze problem constraints and user requirements to structure a feasible and efficient solution.
5. Evaluate multiple design options and justify the chosen solution based on technical and practical considerations.
6. Create a functional prototype or solution that demonstrates innovation, utility, and integration of interdisciplinary knowledge

1) Guidelines for IDEA Project

a) Project Guidelines (Interdisciplinary Project Execution in IDEA Lab)

- Each student works on an individual interdisciplinary project aligned with the semester theme.
- Faculty in-charges for the IDEA Lab are assigned according to the complexity of the project and the capacity of the respective departments.
- Faculty in-charges mentor both the academic and technical aspects, and track weekly progress.
- Project assessment will be rubric-based, ensuring depth, innovation, documentation, and ownership.

- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- Faculty in-charges must attend relevant FDPs to ensure uniformity in mentoring and evaluation.

b) Guidelines for same semester Subject Concepts Applied within the Project

- Termwork for each subject will partially reflect how well a student applies subject-specific concepts in their interdisciplinary project.
- Internal assessment panel will collaborate to align project components with subject learning outcomes.

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c) Role of Faculty In-Charges in IDEA Lab Projects

Faculty in-charges play a pivotal role in the success of interdisciplinary, theme-based projects under the IDEA Lab. Their responsibilities extend beyond technical supervision to include academic alignment, innovation facilitation, and active student engagement. Their key roles include:

1. **Motivating and Inspiring Students**
   - Encourage students to take ownership of their learning and projects.
   - Cultivate a mindset of curiosity, exploration, and social relevance.
   - Foster an environment where students feel empowered to take creative risks.
2. **Conducting Brainstorming and Ideation Sessions**
   - Organize structured brainstorming sessions at the start of the semester to help students define their problem statements and solution pathways.
   - Promote collaborative thinking, design exploration, and interdisciplinary integration.
3. **Arranging Guest Lectures and Expert Talks**
   - Identify and invite industry experts, researchers, and innovators for guest lectures aligned with the semester's theme or subject areas.
   - Facilitate exposure to real-world challenges, current trends, and future opportunities.
4. **Ensuring Uniqueness and Originality of Projects**

- Actively review proposed ideas to ensure **no duplication of solutions** across students.
- Encourage students to explore novel approaches, technologies, and perspectives.

5. **Promoting Discussion and Collaborative Learning**
   - Create platforms for students to present, discuss, and receive peer and mentor feedback.
   - Facilitate idea refinement through regular discussions and group engagement.
6. **Aligning Subject Content Beyond Syllabus**
   - Faculty in-charges must **align subject content beyond the syllabus of the same semester** with the **IDEA Lab theme and assigned problem statements**.
   - This ensures relevance, depth, and meaningful interdisciplinary integration.
7. **Same Semester Faculty Requirement**
   - Faculty in-charges must be teaching subjects in the **same semester** as the students' project to ensure seamless academic integration and contextual understanding.
8. **Monitoring and Documentation**
   - Oversee project logbook maintenance, milestone tracking, and submission of progress reports.
   - Provide ongoing feedback and ensure project alignment with learning outcomes.
9. **Coordination with Subject Faculty**
   - Work in collaboration with other subject faculty to help students embed theoretical and practical aspects of their coursework into the project.
   - Facilitate subject-term mapping and contribute to termwork assessment based on evidence.

2) Implementation Strategy

a) Project Implementation in IDEA Lab

Aspect	Implementation Strategy
Faculty in-charges	**Faculty in-charges assigned based on project nature and department capacity.**
Mentoring Role	**Faculty in-charges oversee academic/technical development, interdisciplinary integration, and timely documentation.**
Capacity Building	**Faculty in-charges undergo workshops on design thinking, innovation, assessment rubrics, and outcome-based mentoring.**

Aspect	Implementation Strategy
Assessment Contribution	**Faculty in-charges contribute to 25 marks allocated for the IDEA Lab project termwork. The remaining assessments are conducted by the external examiner.**
Recognition & Incentives	**Faculty in-charges receive workload credits or are formally acknowledged in performance reviews.**

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b) Implementation of Subject-Term Work Mapping within Projects

Aspect	Implementation Strategy
Mapping Subject Outcomes	**Faculty in-charges align their content beyond syllabus with the student's project by coordinating with the assigned project guide.**
Independent Evaluation	**Internal assessment panel evaluate students based on their application of subject-specific concepts within the project. This contributes to a** separate 25 marks allocated for termwork based on subject **application.**
Evidence Sources	**Evaluation is supported by project logbooks, subject-specific deliverables (e.g., tools, simulations, models), and review presentation inputs.**
Outcome Assurance	**Ensures practical demonstration of subject understanding and its integration into the interdisciplinary solution.**

Implementation Notes:

- Guide faculty assess their course's contribution using specific evidence such as:
    - Logbooks
    - Subject-specific outputs (e.g., simulations, designs)
    - Paper publications or review presentations

2) Guidelines for Assessment

Two-tier rubrics are applied independently to evaluate subject concept application and innovation within the project.

a) Assessment of IDEA Lab Projects (Individual Interdisciplinary Projects) (25 Marks)

Presentation-Based Assessment Structure (Total: 25 Marks)

Assessment Month	Weightage	Marks
Month 1 (Formative 1)	20%	5 marks
Month 2 (Formative 2)	40%	10 marks
Month 3 (Formative 3)	40%	10 marks

Rubric-Based Evaluation Criteria

Criteria	Month 1 (5)	Month 2 (10)	Month 3 (10)
Problem Understanding	Connects problem to subjects	Defines interdisciplinary scope	Demonstrates deep conceptual grasp

Criteria	Month 1 (5)	Month 2 (10)	Month 3 (10)
Subject Knowledge Application	Identifies relevant concepts	Applies principles in design	Integrates multiple subject areas correctly
Innovation & Design Thinking	Proposes creative idea	Develops and tests feasible solution	Final solution shows originality and utility
Documentation & Presentation	Logbook initiated, plan presented	Mid-design log and visuals	Final report and demo completed
Progress & Ownership	Meets deadlines, shows planning	Demonstrates self-motivation	Completes project independently with reflection

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b) Term Work Assessment of Subject Concepts Applied in Projects (25 Marks)

Applicable to All Subjects Integrated with Interdisciplinary Projects

To reflect meaningful application of subject knowledge, each subject will be assessed through the following rubric:

Criteria	Marks	Description
Subject Knowledge Application	8	Depth and accuracy of concept integration into the project
Practical Design or Tool Usage	5	Use of subject-specific hardware/software/simulation/tools
Documentation	4	Quality and clarity of subject-related logs and reports

Criteria	**Marks**	**Description**
Viva/Presentation	4	Ability to explain subject's relevance and role in the project
Continuous Engagement	4	Evidence of consistent participation via logbooks and feedback

c) Total Assessment Structure

Component	Marks	Assessed By
Termwork – Project Execution	25 Marks	Project Guide
Termwork – Application of Subject Concepts	25 Marks	IDEA Lab Panel
Viva Voce (Final Evaluation)	50 Marks	External Examiner

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Course Code	Course Name	Teaching Scheme (Contact Hours Per week)			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14211401	Sampling Theory and Optimization	2	1	--	30	15	--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Semester Exam	Exam Duration (in Hrs)			
		IAT-I	IAT-II	Total					
14211401	Sampling Theory and Optimization	20	20	40	60	2.5	25	--	125

Rationale:

In today's dynamic field of Electronics and Telecommunication Engineering, understanding and managing uncertainty, optimizing system performance, and analyzing complex data are essential skills. This course introduces fundamental concepts of probability and sampling to model randomness inherent in communication systems and signal processing. Building on this foundation, students learn key statistical tools such as the normal, chi-square, and Student's t-distributions to perform hypothesis testing and validate experimental data effectively. To address practical engineering challenges, the course covers linear programming and the simplex method, equipping students with techniques to optimize resource allocation and operational efficiency in networks and embedded systems. Furthermore, queuing theory is used to model and analyze delays, congestion, and throughput in telecommunication networks, which is critical for building robust and high-performance systems. These topics provide Electronics and Telecommunication engineers with a comprehensive analytical framework for dealing with real-world problems involving uncertainty, optimization, and system performance, preparing them for advanced studies and industry challenges in modern communication technologies.

Course Objectives:

1. To introduce statistical measures for analyzing and interpreting experimental data in communication
2. To develop the ability to model and interpret electronic system noise using normal probability distribution.
3. To introduce hypothesis testing methods for performance evaluation in electronics and communication.
4. To familiarize students with tests of independence and variance for system verification.
5. To teach optimization techniques for effective allocation of limited resources in communication networks.
6. To introduce queuing models for analyzing performance and delay in communication systems.

Course Outcomes:

1. Students will be able to analyze data using mean, variance, correlation, and regression for communication system behavior.
2. Students will be able to apply normal distribution to model Gaussian noise in communication channels.
3. Students will be able to evaluate performance metrics using Z-tests and t-tests on experimental data.
4. Students will be able to evaluate categorical data and variances in system performance using Chi-Square and F-tests.
5. Students will be able to solve linear programming problems using the simplex method and understand duality.
6. Students will be able to analyze queuing behavior in networks to estimate performance parameters like average waiting time and queue length.

Prerequisite:

1. Definition of probability, Exhaustive events, Pair wise independent events, Multiplicative law of probability, Conditional probability, Baye's theorem.

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DETAILED SYLLABUS

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	Statistical Techniques	Spearman's Rank correlation coefficient (R) (with repeated and non-repeated ranks)	05	CO1
		Lines of regression		
		Fitting of first- and second-degree curves.		
		Self-learning Topics: 1. Karl Pearson's Coefficient of correlation(r). 2. Fitting of exponential curve. 3. Fitting of logarithmic curve. 4. Covariance	07	
II	Probability Distribution	Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables	05	CO2
		Normal distribution.		
		Expectation, Variance, Moment generating function, Raw and central moments up to 4^{th} order.		
		Central limit theorem.		
		Self-learning Topics: 1. Skewness and Kurtosis of distribution (data). 2. Discrete distribution: Bernoulli, Binomial, Poisson.	07	
III	Sampling theory-I	Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two tailed test, Degree of freedom.	05	CO3
		Test significance for large samples. Test the significance of mean.		

		Students' t-distribution (Small sample). Test the significance of single sample mean and two independent sample means and paired t- test)		
		Self-learning Topics: 1. Estimate parameters of a population. 2. Test of significance of large samples, Proportion test. 3. Difference between the means of two large samples.	08	
IV	Sampling theory-II	Chi-square test: Test of goodness of fit and independence of attributes (Contingency table) including Yate's Correction.	05	CO4
		Analysis of variance: F-test (significant difference between variances of two samples).		
		Self-learning Topics: 1. ANOVA**:** One way classification, 2 . ANOVA**:** Two-way classification (short-cut method).	07	
V	Linear Programming Problems	Types of solutions, Standard and Canonical of LPP, Basic and Feasiblesolutions, slack variables, surplus variables.	05	CO5
		Simplex method.		
		Duality, Dual of LPP.		
		Dual Simplex Method.		
		Self-learning Topics: 1. Artificial variable method, Big M method. 2. Sensitivity Analysis, Two-Phase Simplex Method, Revised Simplex Method.	08	
VI	Queuing Theory	Introduction to Queuing Systems	05	CO6
		Birth-Death Processes & M/M/1 Queues		

		M/M/c and Finite Queue Models		
		M/G/1 and G/G/1 Queues		
		Queuing Networks		
		Self-learning Topics: 1. Priority Queues. 2. Queueing Disciplines. 3. Retrial Queues & Balking/Reneging 4. Queuing with Server Vacations	08	

Text Books:

1. Operations Research, Hira and Gupta, S. Chand Publication.

2. Fundamentals of Statistics, S. C. Gupta.

3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa.

4. Murray Spiegel, “Schaum's Outline of Probability and Statistics”, 4th Edition, Tata McGraw-Hill.

References:

1. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons.

2. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education.

3. Operations Research: An Introduction, Hamdy A Taha, Pearson.

4. Engineering Optimization: Theory and Practice, S.S Rao, Wiley-Blackwell

Online References:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/117103017
2.	https://ocw.mit.edu/courses/res-6-012-introduction-to-probability-spring-2018/
3.	https://archive.nptel.ac.in/courses/117/103/117103017/
4.	https://archive.nptel.ac.in/courses/111/102/111102111/
5.	https://www.youtube.com/playlist?list=PLyqSpQzTE6M_JcleDbrVyPnE0PixKs2JE

Assessment:

Term work (TW) for 25 marks:

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per the university pattern for practical.
2. Students must be encouraged to write **at least 10** class tutorials on entire syllabus.
3. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project.

This project should be graded for 10 marks depending on the performance of the students.

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The distribution of Term Work marks will be as follows –

1. Regularity and active involvement (Theory and Tutorial) 05 marks.

2. Class Tutorials on entire syllabus 10 marks.

3. Mini Project 10 marks.

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					
		L	T	P	L	T	P	SL	Notional Learning Hour	Total Credits (C) (Notional Learning Hour/30)
14212402	Analog and Digital Communication	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT I	IAT II	Total					
14212402	Analog and Digital Communication	20	20	40	60	2.5	--	--	100

Rationale:

Analog and Digital Communication are key to understanding how information is transmitted in modern systems. Analog deals with continuous signals, while digital uses discrete data. Both methods are crucial in applications from radio to the internet. Mastering these concepts

is essential for designing and optimizing communication systems, including emerging technologies like 5G and IoT.

Course Objectives:

1. To demonstrate the fundamental concepts of Analog and Digital Communication Systems.
2. To understand various Analog and Digital Modulation and Demodulation techniques.
3. To analyze and compare the different Modulation and Demodulation techniques.
4. To explain the key concepts of Analog and Digital Pulse Modulation and Demodulation techniques.
5. To illustrate various source and channel coding techniques.
6. To examine the impact of noise and distortions in communication systems.

Course Outcomes:

1. To demonstrate the fundamental concepts of Analog and Digital Communication Systems.
2. To understand various Analog and Digital Modulation and Demodulation techniques.
3. To analyze and compare the different Modulation and Demodulation techniques.
4. To explain the key concepts of Analog and Digital Pulse Modulation and Demodulation techniques.
5. To illustrate various source and channel coding techniques.
6. To examine the impact of noise and distortions in communication systems.

Prerequisite:

- Elements of Telecommunication
- Electronic Devices and Linear Circuits
- Digital System Design

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Need for Modulation, Basics concepts of Amplitude and Frequency Modulation and Demodulation. Sampling Theorem and Pulse Code Modulation. Definition and waveforms of ASK, FSK and PSK.	3	
I	**Introduction**	Block diagram of Analog and Digital Communication System, Signal-to-noise ratio, Noise factor, Noise Figure, Noise Temperature. Friis Formula.	6	**CO1**
		Self-Learning Topics: Types of Noise and Electromagnetic Spectrum. Comparison between Analog & Digital Communication system	6	
II	**Analog Modulation and Demodulation**	**Radio Receivers** – Characteristics of radio receivers, Superheterodyne AM and FM receivers.	4	**CO1 CO2 CO4**
		Self-learning Topics: Use of AM and FM in Modern Communication Technology. Challenges faced by radio broadcasting industry.	6	

III	**Pulse Modulation and Multiplexing**	Sampling Theorem, Nyquist Criteria, Sampling Techniques, Aliasing error and Aperture effect. Generation and Detection of PAM, PWM and PPM. PCM Transmitter and Receiver. Concepts of Delta modulation (DM) and Adaptive Delta Modulation (ADM). Need of Multiplexing, Block Diagram explanation of TDM and FDM Systems.	10	**CO2** **CO4**
		Self-learning Topics: Applications of all the Pulse modulation techniques & Multiplexing, Code Division Multiplexing (CDM/ CDMA)	7	
IV	**Source Coding and Channel Coding Techniques**	Basics of Information Theory, Entropy, Shannon Hartley theorem Source Coding Techniques: Huffman coding and Shannon-Fano coding. Channel Coding for Error Detection and Correction - Linear Block Codes and Convolutional Codes.	7	**CO3** **CO5** **CO6**
		Self-learning Topics: Applications of Source Coding and Channel Coding Techniques. Comparison between Source & channel coding, coding Gain,	8	

		Code rate (k/n), Trade-off between redundancy and reliability		
V	**Baseband Transmission and Reception**	Block diagram of baseband Transmitter-Receiver system, Need of line codes, Properties, Types of line codes - RZ and NRZ Unipolar formats, RZ and NRZ Polar formats, RZ and NRZ Bipolar format (AMI format), Split phase Manchester format and Polar Quaternary formats. Inter Symbol Interference, Inter Channel Interference, Matched Filter.	7	**CO1** **CO2**
		Self-Learning Topics: Bandwidth of baseband signals, Signal-to-noise ratio (SNR), Baseband Channel Characteristics, **ISI**: Overlapping of adjacent pulses due to channel distortion, **Nyquist Criterion**: Condition for zero ISI, Equalizers, Pulse Shaping, Bit Error Rate (BER) Analysis, Applications of Baseband Systems	10	
VI	**Bandpass Transmission and Reception**	Generation, Detection, Error probability and Bandwidth of the following modulations: BASK, BFSK, BPSK, QPSK, offset QPSK, M-ary PSK, 16-ary QASK and MSK.	8	**CO2** **CO4**
		Self-learning Topics: Comparison of Baseband & Bandpass Transmission, Need for Bandpass Transmission,	8	

		Performance Metrics Applications of all the Modulation Techniques		

Text Books:

1. Kennedy and Davis "Electronics Communication System", Tata McGraw Hill
2. Wayne Tomasi, "Electronics Communication Systems" Pearson Education, 5th Edition.
3. Herbert Taub, Donald L Schilling, Goutam Saha, "Principles of Communication Systems", Tata McGraw Hill, 3rd Edition.
4. T. L. Singal, "Analog and Digital Communication," Tata Mc-Graw Hill, New Delhi, First Ed.
5. Sklar B, and Ray P. K., "Digital Communication: Fundamentals and Applications," Pearson, Dorling Kindersley (India), Delhi, Second Edition

References:

1. Simon Haykin, "Communication System", John Wiley and Sons,4th Ed.
2. B P Lathi, Zhi Ding, Modern Digital and Analog Communication Systems, Oxford University. 4th Ed.
3. Beharouz A. Forouzan, "Data Communication and Networking", fourth edition

Online References:

Sr. No.	Website Name
1.	Analog communication- https://swayam.gov.in/nd1_noc20_ee69/preview
2.	Principles of Digital Communication- https://nptel.ac.in/courses/108/101/108101113/
3.	Principles of Digital Communication- https://nptel.ac.in/courses/108/102/108102120/

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Course Code	Course Name	Teaching Scheme (Contact Hours Per Week)			Teaching Scheme (Contact Hours Per Semester)					
		L	T	P	L	T	P	SL	Notional Learning Hour	Total Credits (C) (Notional Learning Hour/30)
14211403	Microcontroller and Application	3	--	--	45	--	--	45	90	3

Course Code	Course Name	Theory					Term work	Prac / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT -1	IAT -2	Total					
14211403	Microcontroller and Application	20	20	40	60	2.5	--	--	100

Rationale:

The Microcontroller and Application course provides foundational and advanced knowledge essential for understanding and developing embedded systems. It builds a strong base in microcomputer components, memory organization, and programming using the 8051 microcontrollers. Students gain practical skills in interfacing, serial communication, and system-level programming. The inclusion of ARM7 and modern microcontrollers ensures relevance to current industry trends. This course prepares students for real-world applications in automation, IoT, and embedded system design.

Course Objectives:

1. To acquire a comprehensive understanding of the essential components and systems that constitute microcomputers

2. To understand the underlying principles, structures, and functionalities of memory systems
3. To understand the architecture and instructions of 8051 microcontrollers.
4. To apply the knowledge of 8051 I/O ports, Timer, Counter, Interrupts, serial port and write the programs related to same
5. To understand the concepts of advanced microcontroller ARM7
6. To apply the concepts of embedded systems and recent microcontrollers

Course Outcomes:

On successful completion of the course student will be able to:

1. Understand of the fundamental components and systems integral to microcomputers
2. Understand the memory systems to optimize system performance.
3. Understand the architecture and instructions of 8051 microcontrollers
4. Apply the concepts of I/O ports, Timer, Counter, Interrupts, serial port for 8051 microcontroller programming.
5. Understand the ARM7 microcontroller architecture and its suitability for embedded systems and real-time applications.
6. Apply the concept of embedded systems and recent advancements in microcontroller technologies and explore their impact on modern applications.

Prerequisite:

Knowledge of Digital System Design

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Overview of Microprocessor based System**	Overview of Components and Systems of Microcomputers. Introduction to the basic components of microcomputers, Significance of signal lines of memory. The actions performed by the microprocessor to fetch and execute instructions from memory after RESET. Concept of RISC & CISC Architecture. Harvard & Von Neumann Architecture.	**06**	CO1
		Self-learning Topics: Students can focus their self-learning on subtopics such as basic components of microcomputers, including CPU, memory, and system buses. They should study the function and importance of signal	**06**	

		lines—address, data, and control—in memory communication. Additionally, they should explore the instruction execution process after RESET and compare RISC vs. CISC architectures and Harvard vs. Von Neumann architectures in terms of design and efficiency.		
II	**The Memory Systems**	Concepts of primary memory and secondary memory, Need of Secondary memory. Types of Semiconductor Memory, Features of SRAM and DRAM. Cache Memory and its need. Concept of virtual memory, Segmentation and Paging.	**03**	CO2
		Self-learning Topics: Students can divide their self-learning into subtopics such as understanding the differences between primary and secondary memory, focusing on speed, volatility, and storage capacity. They should study types of semiconductor memory, including static RAM (SRAM) and dynamic RAM (DRAM), along with their internal working and typical applications. Another subtopic is cache memory, its levels (L1, L2, L3), and how it boosts CPU performance. Finally, they should explore virtual memory mechanisms, emphasizing the concepts of segmentation and paging used in modern operating systems for memory management.	**03**	
III	**8051 Microcontroller & Assembly Language Programming**	Comparison between Microprocessor and Microcontroller. Features, architecture and pin configuration. CPU timing and machine cycle. Memory organization. Addressing modes. Instruction set. Need of Assembler & Compiler, Assembler Directives, Programs related to: arithmetic, logical operations.	**10**	CO3
		Self-learning Topics: Students should begin by exploring the differences between microprocessors and microcontrollers in terms of structure and application. They should study the 8051 microcontroller's architecture, pin configuration, timing diagrams, memory organization, and addressing modes. Further, they should learn the instruction set, understand the role of assemblers and compilers, and practice writing basic	**10**	

		arithmetic and logical programs using assembler directives.		
IV	**8051 I/O Ports, Timer/Counters, Interrupts, Serial Port communication & Interfacing**	8051 Input / Output ports and Port structure. 8051 Timer/Counter, Timer modes. 8051 Interrupt, 8051 serial communication & modes. Assembly language program related to: delay subroutine, input & output port, timer, counter, serial port and Interrupt. Interfacing LEDs, Relay and switches.	**12**	CO4
		Self-learning Topics: Students should focus on understanding the structure and functioning of 8051 I/O ports, and how data is read from or written to these ports. They should learn about 8051 timers/counters, their modes, interrupts, and serial communication, along with related assembly programming. Additionally, they should explore practical interfacing of external devices like LEDs, relays, and switches with the 8051 through hands-on coding and simulations.	**12**	
V	**ARM7**	Introduction and Features of ARM 7, Architectural inheritance, Pipelining, Programmer's Model, Brief introduction of exception and interrupt handling. Concept of cortex A, cortex R and Cortex M. Instruction Set, Data processing, Data Transfer, Control flow.	**08**	
		Self-learning Topics: Students should begin by learning the basic features and architecture of ARM7, including its pipeline structure and programmer's model. They should explore the concepts of exception and interrupt handling, and study the differences between Cortex-A, Cortex-R, and Cortex-M series. Finally, they should understand the ARM instruction set, focusing on data processing, data transfer, and control flow instructions.	**08**	
VI	**Study 8-bit microcontroller Applications**	Definition of Embedded System, Embedded Systems Vs General Computing Systems. Factors to be Considered in Selecting a Microcontroller for an Application. Understanding features of ATMEGA 328, LPC2148, MSP430 and STM 32	**06**	CO6

		Microcontrollers. Case Study on microcontroller-based applications.		
		Self-learning Topics: Students should begin by understanding the definition and core components of embedded systems, along with how they differ from general-purpose computing systems in terms of functionality and constraints. They should explore the key factors to consider when choosing a microcontroller, such as processing speed, memory, power efficiency, and I/O capabilities. In-depth study of the features and architectures of popular microcontrollers like ATMEGA328, LPC2148, MSP430, and STM32 is essential. Finally, analyzing case studies of real-world applications will help students understand practical implementations and industry relevance.	**06**	

Text Books:

1. M. A. Mazidi, J. G. Mazidi and R. D. Mckinlay, "The 8051 Microcontroller & Embedded systems", Pearson Publications, Second Edition 2006.
2. C. Kenneth J. Ayala and D. V. Gadre, "The 8051 Microcontroller & Embedded system using assembly & 'C' ", Cengage Learning, Edition 2010
3. Raj Kamal, "Microcontrollers" Architecture, Programming, Interfacing and System Design", Pearson Education India, Second Edition 2011
4. N. Senthil Kumar, M. S. P. S. A. Kumar, "Microprocessor and Microcontroller", Oxford University Press, 2nd edition
5. I. Scott MacKenzie and Raphael C.W. Phan, "The 8051 Microcontroller", Pearson Education International, 4th edition
6. Steve Furber, "ARM System on chip Architecture", Pearson, 2nd edition

References:

1. "MCS@51 Microcontroller, Family User's Manual" Intel
2. ATmega328P 8-bit AVR Microcontroller with 32K Bytes In-System Programmable Flash datasheet, Atmel
3. James A. Langbridge, "Professional Embedded Arm Development", Wrox, John Wiley Brand& Sons Inc., Edition 2014
4. Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide: Designing and Optimizing System Software", Elsevier
5. The 8051 Microcontroller and Embedded Systems, "Manish K Patel", McGraw Hill 2014

Sr. No.	**NPTEL / Swayam Course**
1.	Microprocessors and Microcontrollers By Prof. Santanu Chattopadhyay (IIT Kharagpur) - https://swayam.gov.in/nd1_noc20_ee42/preview
2.	PLC and Microcontroller By Dr Ritula Thakur (NITTTR, Chandigarh) - https://onlinecourses.swayam2.ac.in/ntr25_ed25/preview

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits(C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14212404	**Analog and Digital Communication Laboratory**	--	--	2	--	--	30	--	30	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT I	IAT II	Total				
14212404	**Analog and Digital Communication Laboratory**	--	--	--	--	25	25	50

Prerequisite:

- Elements of Telecommunication
- Electronic Devices and Linear Circuits
- Digital System Design

Lab Objectives:

1. To demonstrate generation and detection of Analog and Digital Modulation techniques.
2. To demonstrate generation and detection of Pulse Modulation Techniques.
3. To learn source coding and error control coding techniques.
4. To compare different line coding methods.
5. To illustrate multiplexing techniques.
6. To use simulation tools for analog and digital communication techniques.

Lab Outcomes:

1) Demonstrate various Analog Modulation and Demodulation techniques.
2) Demonstrate Pulse Modulation, Demodulation and Multiplexing techniques.
3) Demonstrate various Digital Modulation and Demodulation Techniques.
4) Evaluate the performance parameters of a communication system.
5) Examine various Line Coding Techniques.
6) Design different source coding and channel coding Techniques.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction**	Noise voltage and Noise Power Calculations	02	LO1
II	**Analog Modulation and Demodulation**	DSBFC Modulation and Demodulation, DSBSC, Diode Detector FM Modulation and Demodulation, Pre-emphasis and De-Emphasis	06	LO1 LO4
III	**Pulse Modulation and Multiplexing**	Sampling Theorem Analog Pulse Modulation Techniques -PAM, PWM, PPM. Digital Pulse Modulation Techniques- PCM, DM, ADM Multiplexing Techniques - TDM and FDM	06	LO2

IV	**Source Coding and Channel Coding**	Source Coding Techniques- Shannon Fano Coding and Huffman Coding Channel Coding Techniques - Linear Block Codes and Convolution Codes	04	LO6
V	**Baseband Transmission and Reception**	Line Codes, Matched Filter	02	LO4 LO5
VI	**Bandpass Transmission and Reception**	Modulation and Demodulation of ASK, FSK, PSK, QPSK Techniques	04	LO3

List of Experiments

Sr No	List of Experiments	Hrs
01	Generation and Detection of Amplitude Modulation	02
02	Generation and Detection of Frequency Modulation	02
03	Generation and Detection of DSBSC Signal.	02
04	Design and implementation of Pre-emphasis and De-emphasis circuit.	02
05	Verification of sampling theorem.	02
06	Generation of PAM Modulation /Demodulation.	02
07	Generation of PWM/PPM Modulation /Demodulation.	02
08	Demonstrate Digital Pulse Code Modulation Technique (PCM)	02
09	Demonstrate Delta Modulation and Adaptive Delta Modulation Techniques (DM, ADM)	02
10	Observation of Time Division multiplexing and De-multiplexing signals.	02
11	Observation of Frequency Division multiplexing and De-multiplexing signals.	02

12	Simulate Shannon-Fano Code and calculate code efficiency	02
13	Simulate Huffman code and calculate code efficiency.	02
14	Simulate Linear block code and find error detection capability.	02
15	Simulate Convolutional code as per given specification.	02
16	Observe and compare of various Line Codes.	02
17	Matched filter impulse response for a given input.	02
18	Modulation/Demodulation of Binary ASK.	02
19	Modulation/Demodulation of Binary FSK.	02
20	Modulation/Demodulation of Binary PSK.	02
21	Modulation/Demodulation of QPSK.	02
22	Generation (and detection) of MSK	02

Text Books:

1. Kennedy and Davis “Electronics Communication System”, Tata McGraw Hill
2. Wayne Tomasi, “Electronics Communication Systems” Pearson Education, 5th Edition.
3. Herbert Taub, Donald L Schilling, Goutam Saha, “Principles of Communication Systems”, Tata McGraw Hill, 3rd Edition.
4. T. L. Singal, “Analog and Digital Communication,” Tata Mc-Graw Hill, New Delhi, First Ed.
5. Beharouz A. Forouzan, “Data Communication and Networking” fourth edition

References:

1. Sklar B, and Ray P. K., “Digital Communication: Fundamentals and Applications,” Pearson, Dorling Kindersley (India), Delhi, Second Edition.

2. Modern Digital and Analog Communication Systems, Oxford University. 4th Ed.

Online Resources:

Sr. No.	Website Name
1.	Analog communication- https://swayam.gov.in/nd1_noc20_ee69/preview
2.	Principles of Digital Communication- https://nptel.ac.in/courses/108/101/108101113

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practical's based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

R-2025- S E Electronics and Telecommunication Engineering

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					
		L	T	P	L	T	P	SL	Notional Learning Hour	Total Credits (C) (Notional Learning Hour/30)
14212405	IDEA LAB - 4 (Innovation Design Engineering and Apply)	1	--	2	15	--	30	15	60	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT 1	IAT 2	TOTAL				
14212405	IDEA LAB - 4(Innovation Design Engineering and Apply)	--	--	--	--	50	50	100

Rationale :

Aligned with the National Education Policy (NEP) 2020, the institution emphasizes experiential, interdisciplinary, and project-based learning through the IDEA Lab—a central hub for hands-on innovation.

To strengthen the undergraduate research ecosystem, the institution has adopted a theme-based academic model aligned with UN SGD. Each semester features six curated problem statements based on local need and aligned with core subjects in the same semester, enabling students to apply classroom knowledge to real-world challenges. Every student selects one problem and develops an individual, subject-integrated solution—enhancing both academic understanding and research skills.

The IDEA Lab supports this initiative with facilities for design thinking, prototyping, and product development. Students maintain a project logbook throughout the semester to track their progress and reflections.

To ensure academic accountability, a two-tier assessment framework is implemented:

- Project Assessment based on standardized IDEA Lab rubrics.
- Subject-Based Term Work Assessment focused on the application of same-semester subject knowledge in the project.

Lab Objectives:

1. To promote experiential and project-based learning that bridges theoretical knowledge with real-world problem-solving.
2. To encourage interdisciplinary integration by enabling students to apply concepts from multiple subjects within a single cohesive project.
3. To develop innovation and design thinking skills through hands-on activities and iterative solution development.
4. To foster critical thinking and creativity by engaging students in open-ended problems with multiple solution pathways.
5. To enhance communication, collaboration, and documentation skills essential for professional engineering practice.
6. To build an entrepreneurial and research mindset by guiding students to develop scalable, socially-relevant, and technically viable prototype

Lab Outcomes: Student will be able to

1. Recall and articulate key concepts from core and allied subjects relevant to the assigned project.
2. Explain the interdisciplinary nature of the problem and the role of each subject in addressing it.
3. Apply appropriate tools, techniques, and theoretical knowledge to develop project components.
4. Analyze problem constraints and user requirements to structure a feasible and efficient solution.
5. Evaluate multiple design options and justify the chosen solution based on technical and practical considerations.
6. Create a functional prototype or solution that demonstrates innovation, utility, and integration of interdisciplinary knowledge

1) Guidelines for IDEA Project

a) Project Guidelines (Interdisciplinary Project Execution in IDEA Lab)

- Each student works on an individual interdisciplinary project aligned with the semester theme.
- Faculty in-charges for the IDEA Lab are assigned according to the complexity of the project and the capacity of the respective departments.
- Faculty in-charges mentor both the academic and technical aspects, and track weekly progress.
- Project assessment will be rubric-based, ensuring depth, innovation, documentation, and ownership.
- Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.
- Faculty in-charges must attend relevant FDPs to ensure uniformity in mentoring and

evaluation.

b) Guidelines for same semester Subject Concepts Applied within the Project

- Termwork for each subject will partially reflect how well a student applies subject-specific concepts in their interdisciplinary project.
- Internal assessment panel will collaborate to align project components with subject learning outcomes.

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c) Role of Faculty In-Charges in IDEA Lab Projects

Faculty in-charges play a pivotal role in the success of interdisciplinary, theme-based projects under the IDEA Lab. Their responsibilities extend beyond technical supervision to include academic alignment, innovation facilitation, and active student engagement. Their key roles include:

1. **Motivating and Inspiring Students**
   - Encourage students to take ownership of their learning and projects.
   - Cultivate a mindset of curiosity, exploration, and social relevance.
   - Foster an environment where students feel empowered to take creative risks.
2. **Conducting Brainstorming and Ideation Sessions**
   - Organize structured brainstorming sessions at the start of the semester to help students define their problem statements and solution pathways.
   - Promote collaborative thinking, design exploration, and interdisciplinary integration.
3. **Arranging Guest Lectures and Expert Talks**
   - Identify and invite industry experts, researchers, and innovators for guest lectures aligned with the semester's theme or subject areas.
   - Facilitate exposure to real-world challenges, current trends, and future opportunities.
4. **Ensuring Uniqueness and Originality of Projects**
   - Actively review proposed ideas to ensure **no duplication of solutions** across students.
   - Encourage students to explore novel approaches, technologies, and perspectives.
5. **Promoting Discussion and Collaborative Learning**

- Create platforms for students to present, discuss, and receive peer and mentor feedback.
- Facilitate idea refinement through regular discussions and group engagement.

6. **Aligning Subject Content Beyond Syllabus**
   - Faculty in-charges must **align subject content beyond the syllabus of the same semester** with the **IDEA Lab theme and assigned problem statements**.
   - This ensures relevance, depth, and meaningful interdisciplinary integration.
7. **Same Semester Faculty Requirement**
   - Faculty in-charges must be teaching subjects in the **same semester** as the students' project to ensure seamless academic integration and contextual understanding.
8. **Monitoring and Documentation**
   - Oversee project logbook maintenance, milestone tracking, and submission of progress reports.
   - Provide ongoing feedback and ensure project alignment with learning outcomes.
9. **Coordination with Subject Faculty**
   - Work in collaboration with other subject faculty to help students embed theoretical and practical aspects of their coursework into the project.
   - Facilitate subject-term mapping and contribute to termwork assessment based on evidence.

2) Implementation Strategy

a) Project Implementation in IDEA Lab

Aspect	Implementation Strategy
Faculty in-charges	**Faculty in-charges assigned based on project nature and department capacity.**
Mentoring Role	**Faculty in-charges oversee academic/technical development, interdisciplinary integration, and timely documentation.**
Capacity Building	**Faculty in-charges undergo workshops on design thinking, innovation, assessment rubrics, and outcome-based mentoring.**
Assessment Contribution	**Faculty in-charges contribute to 25 marks allocated for the IDEA Lab project termwork. The remaining assessments are conducted by the external examiner.**

Aspect	Implementation Strategy
Recognition & Incentives	**Faculty in-charges receive workload credits or are formally acknowledged in performance reviews.**

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b) Implementation of Subject-Term Work Mapping within Projects

Aspect	Implementation Strategy
Mapping Subject Outcomes	**Faculty in-charges align their content beyond syllabus with the student's project by coordinating with the assigned project guide.**
Independent Evaluation	**Internal assessment panel evaluate students based on their application of subject-specific concepts within the project. This contributes to a** separate 25 marks allocated for termwork based on subject **application.**
Evidence Sources	**Evaluation is supported by project logbooks, subject-specific deliverables (e.g., tools, simulations, models), and review presentation inputs.**
Outcome Assurance	**Ensures practical demonstration of subject understanding and its integration into the interdisciplinary solution.**

Implementation Notes:

- Guide faculty assess their course's contribution using specific evidence such as:
  - Logbooks
  - Subject-specific outputs (e.g., simulations, designs)
  - Paper publications or review presentations

2) Guidelines for Assessment

Two-tier rubrics are applied independently to evaluate subject concept application and innovation

within the project.

a) Assessment of IDEA Lab Projects (Individual Interdisciplinary Projects) (25 Marks)

Presentation-Based Assessment Structure (Total: 25 Marks)

Assessment Month	**Weightage**	**Marks**
Month 1 (Formative 1)	20%	5 marks
Month 2 (Formative 2)	40%	10 marks
Month 3 (Formative 3)	40%	10 marks

Rubric-Based Evaluation Criteria

Criteria	**Month 1 (5)**	**Month 2 (10)**	**Month 3 (10)**
Problem Understanding	Connects problem to subjects	Defines interdisciplinary scope	Demonstrates deep conceptual grasp
Subject Knowledge Application	Identifies relevant concepts	Applies principles in design	Integrates multiple subject areas correctly

Criteria	Month 1 (5)	Month 2 (10)	Month 3 (10)
Innovation & Design Thinking	Proposes creative idea	Develops and tests feasible solution	Final solution shows originality and utility
Documentation & Presentation	Logbook initiated, plan presented	Mid-design log and visuals	Final report and demo completed
Progress & Ownership	Meets deadlines, shows planning	Demonstrates self-motivation	Completes project independently with reflection

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b) Term Work Assessment of Subject Concepts Applied in Projects (25 Marks)

Applicable to All Subjects Integrated with Interdisciplinary Projects

To reflect meaningful application of subject knowledge, each subject will be assessed through the following rubric:

Criteria	Marks	Description
Subject Knowledge Application	8	Depth and accuracy of concept integration into the project
Practical Design or Tool Usage	5	Use of subject-specific hardware/software/simulation/tools
Documentation	4	Quality and clarity of subject-related logs and reports
Viva/Presentation	4	Ability to explain subject's relevance and role in the project

Criteria	**Marks**	**Description**
Continuous Engagement	4	Evidence of consistent participation via logbooks and feedback

c) Total Assessment Structure

Component	Marks	Assessed By
Termwork – Project Execution	25 Marks	Project Guide
Termwork – Application of Subject Concepts	25 Marks	IDEA Lab Panel
Viva Voce (Final Evaluation)	50 Marks	External Examiner

Course Code	Course Name	Teaching Scheme (Contact Hours Per Week			Teaching Scheme (Contact Hours Per Semester)					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
14412406	Smart Embedded Systems with Atmega 168/328	--	--	2	--	--	30	--	30	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT-1	IAT-2	Total				
14412406	Smart Embedded Systems with Atmega 168/328	--	--	--	--	25	25	50

Lab Objectives:

1. To understand the architecture, memory organization, and peripheral features of the ATmega168/328 microcontroller.
2. To explore internal functional blocks like timers, ADC, PWM, and serial communication interfaces.
3. To gain proficiency in embedded C programming using development tools for microcontroller programming and interfacing.

4. To interface wireless modules, sensors, actuators, and integrate IoT platforms for real- time control and monitoring.
5. To design, develop, and convert a prototype into a marketable embedded product considering DFM and cost analysis.
6. To design schematics and PCB layouts using EDA tools and apply fabrication standards Lab.

Lab Outcomes:

After successful completion of the course student will be able to:

1. Identify pin configurations, explain memory types, and write simple code to configure I/O ports.
2. Configure and program internal peripherals like timers, interrupts, and serial communication modules (USART, SPI, I2C).
3. Develop, compile, and upload programs using IDEs, and implement sensor interfacing and interrupt handling.
4. Design and build embedded applications integrating sensors, actuators, displays, and wireless modules with cloud-based data logging and control.
5. Create a prototype, optimize it for production, and present a final project report including BOM and feasibility study.
6. Create a PCB layout, follow design rules, and generate Gerber files for the fabrication of microcontroller-based projects.

DETAILED SYLLABUS:

Sr No	Name of Module	Detailed Content	Hours	LO Mapping
I	**Introduction to ATmega168/328 Microcontroller**	Overview of Microcontrollers and Microprocessors, Introduction to AVR Family, Features and Specifications of ATmega168/328, Pin Diagram and Pin Description, Clocking and Power Management, Memory Organization: Flash,	**4**	**LO1**

		SRAM, EEPROM, I/O Ports and Peripheral Features		
		Self-learning Topics: RAM and its Types of RAM, ROM and Its Types, Difference between RAM and ROM, Different ways of Clock Generation		
II	**ATmega168/328 Architecture**	Detailed Architecture and Block Diagram, Registers and Memory Mapping, Timers and Counters, Interrupt Handling, ADC (Analog to Digital Conversion), PWM (Pulse Width Modulation) USART, SPI, and I2C Communication	**4**	**LO2**
		Self-learning Topics: Types of IO Mapping, Interrupt and its types, PWM (Pulse Width Modulation), Types of Communication (serial and Parallel), Difference between Serial and Parallel Communication, Serial communication Frame Format (UART)		
III	**Programming ATmega168/328**	Introduction to Embedded C Programming, Basic Data types, Functions & Pointers, Data Structures, Memory & Optimization, Bit Manipulation & Efficiency, Installation and Setup of IDEs like Keil, Atmel Studio / Microchip Studio, Platform IO (with VS Code), Eclipse with AVR Plugin (AVR-Eclipse),AVR-GCC + Make files (Bare Metal CLI), GPIO Interfacing and LED Blinking, Analog and Digital Sensor Interfacing, Serial Communication Programming, ISR for Interrupt handling	**6**	**LO3**
		Self-learning Topics: Basics of embedded c programming, Various IDE for microcontroller programming, I/O pins and sensor interfacing, Serial communication and interrupt handling		
IV	**Advanced Technologies and Project Integration**	Introduction to Wireless Communication (Bluetooth, Wi-Fi, Zigbee, RF434Mhz, LoRa), Introduction to modules of Wireless identification (RFID-RC-522), EM-18,	**6**	**LO4**

		(nRF24L01), Introduction to Sensors like IR (Obstacle, Gas, Fire, DHT11, Obstacle, Soil Moisture, Ultrasonic (HC-SR-04), Touch, Biometric Pressure (BMP180/280), Soil Sensor moisture, water Sensor, Heart Rate (Max30100), PIR, Gyroscope (MPU6050), magneto meter (HMC5883L), Accelerometer (ADXL345), Finger Print Sensor(R305), Camera Modules (e.g., OV7670), Strain Gauge, Voltage (ZMPT101B), Current (ACS712) and Power Sensor (PZEM-004T) or similar etc. Introduction to Actuator like Relay, Motor (DC Motor, Stepper, Servo), Buzzer, Motor Control using L293D/L298N Motor Driver, Relay Control using ULN2803, Stepper Control using ULN 2003/2803, Servo Motor Control, Interfacing of LCD, LED, OLED,7Segment, IoT Integration with ATmega (Cloud Like Thing speak, MQTT, Blynk, Google Firebase or Similar), Real-Time Data Monitoring and Control, Using above Hardware/Controller define the Project define problem statement to make a project and into product **Self-learning Topics:** Wireless communication and its type, Sensor and its pin diagram for interfacing, Actuator and its pin diagram for interfacing, Display and its pin diagram for interfacing, IOT integration with embedded systems.		
V	**Project Development, Testing and Product Conversion**	System Design and Block Diagram Creation, Component Selection and Circuit Design, Prototype Development and Testing, Debugging Techniques, Software and Hardware Integration, Design for Manufacturing (DFM), Enclosure Design, Cost Estimation and Bill of Materials (BOM), Market Analysis and Feasibility Study, Final Project Report, Presentation and Research Paper.	**5**	**LO5**

		Self-learning Topics: 3D Printing, Types of 3D printing, Material used in 3D printing, Basics of 3D printing model, 3D modelling Software, how to use that software, Basic knowledge of cost estimation and bills of material, Idea to product development procedure		
VI	**PCB Design for Microcontroller Projects**	Introduction to PCB Design, PCB Layout and Schematic Creation, Tools for PCB Design: Proteus, Eagle, Altium Designer, KiCAD, Easy EDA or any similar tool, Design Rules and Guidelines, PCB Fabrication Process	**5**	**LO6**
		Self-learning Topics: PCB, Types of PCB, Material used for PCB and their advantages, Disadvantages and Application, Standard PCB design processes, Basic knowledge about PCB design tools, PCB design rules for compact design structure. PCB fabrication process		

List of Experiments.

Sr No	List of Experiments	Hrs
01	Installation of IDE used and how to write a program, compile, and Upload	2
02	Interfacing of Buzzer, LED, Relay, Motors	2
03	Interfacing of different Sensors	2
04	Interfacing of Different cloud Platform & Database	2
05	Designing of circuit diagram of project	2
06	Designing of PCB on Software	2
07	Fabrication the Designed PCB	2
08	Preparing the PCB	2

09	Testing the PCB	2
10	Assembling project	2
11	Testing the Final Project	2
12	Designing of enclosure on 3d Printing Software	2
13	Printing the enclosure	2
14	Preparing Bill of Material, Market analysis and Feasibility study	2
15	Writing Research Paper	2

Textbooks:

1. "AVR Microcontroller and Embedded Systems" by Muhammad Ali Mazidi, Sarmad Naimi, and Sepehr Naimi.
2. "Programming and Customizing the AVR Microcontroller" by Dhananjay V. Gadre.
3. "Embedded Systems: Real-Time Interfacing to ARM Cortex-M Microcontrollers" by Jonathan Valvano.
4. "Introduction to Embedded Systems" by Shibu K V.
5. "Embedded C Programming and the Atmel AVR" by Barnett, Cox, and O'Cull.
6. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing" by Ian Gibson, David Rosen, Brent Stucker
7. PCB Design Tutorial" by David L. Jones (EEVblog)

Reference Books:

1. "AVR Programming: Learning to Write Software for Hardware" by Elliot Williams
2. "Microcontroller Projects in C for the 8051" by Dogan Ibrahim
3. "The AVR Microcontroller and Embedded Systems Using Assembly and C" by Muhammad Ali Mazidi.
4. "Designing Embedded Systems with PIC Microcontrollers" by Tim Wilmshurst.
5. "Fundamentals of Microcontrollers and Applications in Embedded Systems" by Ramesh S. Gaonkar

6. "3D Printing for Dummies" *(Introductory & DIY-friendly)* By Kalani Kirk Hausman, Richard Horne
7. "Designing Printed Circuits Boards with KiCad" by Peter Dalmaris

Software Tools:

1. Arduino IDE: https://www.arduino.cc/en/software
2. Atmel Studio: https://www.microchip.com/en-us/tools-resources/develop/microchip-studio
3. Microchip Studio: https://www.microchip.com/en-us/tools-resources/develop/microchip-studio
4. PlatformIO: https://platformio.org/install/integration & https://platformio.org/platformio-ide
5. Visual Studio Code: https://code.visualstudio.com/
6. AVR-GCC (GNU AVR C Compiler): https://gcc.gnu.org/wiki/avr-gcc
7. SimulAVR or AVRSim (Simulation Tools): https://sourceforge.net/projects/simulavr/
8. 3D Model Design Website https://www.sketchup.com/
9. Spline - 3D Design tool in the browser with real-time collaboration 3D Models for Free - Free3D.com

Online Resources:

Sr. No.	Website Name
1.	Microchip Technology – ATmega328P Datasheet: Detailed specifications and features of the ATmega328P microcontroller. https://ww1.microchip.com/downloads/en/DeviceDoc/Atmel-7810-Automotive-Microcontrollers-ATmega328P_Datasheet.pdf
2.	AVR Libc – NonGNU.org: Comprehensive user manual for AVR Libc, providing standard C library functions for AVR microcontrollers.nongnu.org+1Courses at Washington University+1 https://www.nongnu.org/avr-libc/user-manual/

3.	Arduino Official Website: Resources, tutorials, and documentation for Arduino boards and software. https://www.arduino.cc/
4	SparkFun Inventor's Kit Experiment Guide: Step-by-step projects and experiments using the SparkFun Inventor's Kit.Microchip Docs+2SparkFun Learn+2SparkFun Learn+2 https://learn.sparkfun.com/tutorials/sparkfun-inventors-kit-experiment-guide---v41
5	Microchip Developer Help: Comprehensive online resource for developers using Microchip's products and technologies.Developer Help https://developerhelp.microchip.com/xwiki/bin/view/Main/
6	KiCad EDA – Schematic Capture & PCB Design Software: Open-source software suite for electronic design automation.Altium+6 Wikipedia+6KiCad EDA+6 https://www.kicad.org/
7	Autodesk EAGLE: Electronic design automation software for PCB designers.Autodesk https://www.autodesk.com/products/eagle/overview
8	Altium Designer: Industry-leading PCB design software combining schematic, layout, and more.Altium https://www.altium.com/
9	ThingSpeak – IoT Analytics Platform: Platform for aggregating, visualizing, and analyzing live data streams in the cloud.Halvorsen Blog+3ThingSpeak+3MathWorks - Maker of MATLAB and Simulink+3 https://thingspeak.com/
10	Blynk IoT Platform: Low-code platform for building and managing IoT applications. https://blynk.io/

11	3D printing : Tinkercad (by Autodesk) https://www.tinkercad.com
12	3D printing : FreeCAD (Open Source CAD Software) https://www.freecadweb.org

Guidelines for execution of syllabus and maintain quality of mini project are as follows:
Teaching Approach:

1. Modules 1, 2, and 3 shall be taught in parallel to provide an integrated learning experience.

2. After covering the theoretical concepts of ATmega328 microcontroller architecture and its features, programming fundamentals should be introduced.

3. Embedded C programming should be taught in the context of microcontroller programming.

4. Initial programming exercises should focus on developing a strong understanding of Embedded C syntax and structure specific to microcontroller applications.

5. Subsequently, fundamental programming related to GPIO, Timers, and Interrupts must be covered along with their practical implementation on the ATmega328 microcontroller.

6. Module 4 shall focus on interfacing various sensors, actuators, and communication protocols with the ATmega328 microcontroller, covering their working principles and practical implementation on the development board.

7. Hands-on experiments must be conducted for each interfacing to ensure practical understanding and testing of sensors, actuators, and communication protocols.

8. After thorough understanding and practical exposure to Modules 1, 2, 3, and 4, students should proceed with project selection and execution based on the ATmega328 microcontroller.

Project Topic Selection and Approval:

1. A mini-project group shall consist of a minimum of THREE (03)

2. Project topic selection and approval should be done by a panel of two expert faculty members from the department.

3. Each group must maintain a logbook to record weekly work progress in terms of milestones. The guiding faculty should provide remarks/comments weekly. Both students and faculty must sign the logbook every week.

Project Report Format:

1. The mini-project report should include the following sections:
    - Abstract (maximum 1 page summarizing the complete report)
    - Introduction (justification for project selection, applications, and existing commercial products)
    - Implementation (proposed specifications, block diagram/circuit diagram, working principle/operation)
    - Results & Discussion (photographs, video links, recorded results such as waveforms/observations/demonstrations)
    - Conclusion and Learning Outcomes
    - References
    - Participation in Mini-project competition/Technical Paper Presentation (TPP), etc.
2. The report should not exceed 10 pages. Reports should be stapled to avoid the use of plastic.

Assessment:

Term Work & Practical/Oral Examination Evaluation:

1. Minimum six (06) experiments based on Modules 1, 2, 3, and 4 should be performed.
2. One mini project must be implemented.
3. It is not compulsory to select a project from the given sample list; students are encouraged to propose innovative ideas.

4. Students must deliver a presentation and demonstrate their mini project during the Practical and Oral Examination (25 Marks Evaluation).

5. Project reports must be checked for plagiarism using software such as Turnitin or any equivalent tool.

6. Evaluation should consider each student's individual contribution, understanding, and knowledge gained during the project execution. Marks should be awarded accordingly.

Term Work & Evaluation Scheme (Total 25Marks):

Component	**Marks**
Performance in Experiments & Evaluation by Guide	05
Performance in mini project & Evaluation by Guide	05
Performance in mini project & Evaluation by Review Committee Evaluation	05
Logbook and Quality of Project Report	05
Research Paper	05

Practical& Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

List of Mini Projects:

Note: This is tentative list student select any other good topic which should have 2-3 sensor, 2-3 actuator, 2 Cloud Platform and database.

Mini Project Topic	
1	**Title: Smart Environment Monitor: Temperature & Gas Alert System** **Synopsis:** This project integrates a ATMEGA168/328 with a DHT11 sensor to measure temperature and humidity, along with a gas sensor to detect harmful gas leaks. An OLED display shows real-time data locally. The system sends sensor data to both Blynk and Thing speak for remote monitoring. Alerts are triggered if the values exceed safe limits, ensuring prompt action. This IoT solution is ideal for home or industrial environmental safety Sensors used: DHT11, Gas Sensor Actuator used: OLED, Buzzer, LED Cloud Platform: Bynk, Thing speak
2	**Title: Smart Irrigation System: Automated Plant Watering** **Synopsis:** Using a soil moisture sensor interfaced with ATMEGA168/328, this project continuously monitors the moisture level of the soil. When moisture falls below a preset threshold, a water pump is automatically activated to irrigate the plants. Data is logged and displayed remotely via Thing speak and Blynk, allowing users to track plant health. It's a practical application of IoT in agriculture and home gardening. Sensors used: Soil Moisture Sensor Actuator used: Water Pump, Buzzer, LED Cloud Platform: Blynk, Thing speak
3	**Title: Dual Sensor Alert: Obstacle & Metal Detection System** **Synopsis:** This project combines a proximity sensor with an IR sensor on an ATMEGA168/328 platform to detect obstacles and metallic objects. When an object is detected, the system immediately sends a signal via the Blynk app for real-time monitoring. It can be used for security or automated machinery, ensuring safety and operational efficiency. Sensors used: Proximity Sensor, IR Sensor Actuator used: Buzzer, LED Cloud Platform: Blynk

4.	**Title: Automatic Parking gate** **Synopsis:** Integrating an IR sensor with a servo motor, this ATMEGA168/328 project automates parking space management. The IR sensor detects the presence of a vehicle, while the servo motor operates the parking gate. Communication through MQTT ensures real-time updates and remote monitoring of parking slot availability. Sensors used: IR Sensor Actuator used: Servo Motor, Buzzer, LED Cloud Platform: MQTT
5.	**Title: Clean Air Sentinel: Air Quality Monitoring & Alert System** **Synopsis:** This project uses ATMEGA168/328 paired with an MQ135 sensor and an additional gas sensor to monitor ambient air quality. Readings are displayed on an LCD and transmitted via MQTT for remote monitoring. When pollutant levels exceed safe thresholds, the system generates an alert. It is suitable for both indoor and outdoor environments, promoting health and safety. Sensors used: MQ135, Gas Sensor Actuator used: LCD, Buzzer, LED Cloud Platform: MQTT, Blynk
6.	**Title: Smart Water Tank: Automated Water Level Control System** **Synopsis:** In this project, an ultrasonic sensor connected to ATMEGA168/328 monitors the water level in a tank continuously. When water levels drop below a predetermined level, a water pump is automatically activated to refill the tank. Real-time data is sent through MQTT to a cloud-based dashboard for remote supervision. This system ensures efficient water management and minimizes wastage. Sensors used: Ultrasonic Sensor Actuator used: Water Pump, LED, Buzzer Cloud Platform: MQTT, Blynk

7.	**Title: Smart Waste Manager: Automated Dustbin Monitoring System** **Synopsis:** This project employs an ultrasonic sensor to measure the fill level of a dustbin, with a servo motor mechanism for automated lid control. A buzzer sounds an alert when the bin nears capacity. Sensor data is sent to both Thing speak and Blynk, enabling remote monitoring and timely waste collection. The system aims to maintain cleanliness and optimize waste management processes. Sensors used: Ultrasonic Sensor Actuator used: Servo Motor, Buzzer, LED Cloud Platform: Thing speak, Blynk
8.	**Title: Safety First: Temperature & Fire Early Warning System** **Synopsis:** A DS18B20 temperature sensor and a fire sensor work with ATMEGA168/328 to monitor critical environmental parameters. An LCD provides local readouts while data is sent via MQTT and Thing Speak to cloud platforms for remote access. Alerts are triggered when temperature or fire hazards are detected, ensuring early intervention. Sensors used: DS18B20, Fire Sensor Actuator used: LCD, Buzzer, LED Cloud Platform: Thing speak, MQT
9.	**Title: Cloud Guard: Comprehensive Fire & Environmental Monitoring System** **Synopsis:** This project combines DHT11, gas, and fire sensors with ATMEGA168/328 to continuously monitor temperature, humidity, and fire risks. An LCD displays current readings while data is uploaded to Thing speak and Blynk for remote access. Automated alerts notify users of any hazardous conditions, facilitating quick responses. Sensors used: DHT11, Gas Sensor, Fire Sensor Actuator used: LCD, Buzzer, LED Cloud Platform: Thing speak, Blynk

10.	**Title: Guardian Fall Alert: IoT-based Fall Detection and Response** **Synopsis:** Using a gyroscope sensor interfaced with ATMEGA168/328, this system detects abnormal movements indicative of a fall. A buzzer provides immediate local alerts, while sensor data is shared with Thing speak and Blynk for remote monitoring. The project is designed to assist elderly individuals or those at risk by ensuring rapid response in emergencies. Sensors used: Gyroscope Sensor, SOS button Actuator used: Buzzer, LED Cloud Platform: Thing speak, Blynk
11.	**Title: Atmospheric Insights: Multi-parameter Environmental Monitor** **Synopsis:** Utilizing the BMP280 sensor with ATMEGA168/328, this project measures temperature, pressure, and humidity simultaneously. An OLED display presents real-time environmental data, while MQTT transmits the readings to remote platforms. The system provides comprehensive weather insights and alerts if values deviate from normal, applicable in both indoor and outdoor environments. Sensors used: BMP280 Actuator used: OLED, Buzzer, LED Cloud Platform: MQTT, Blynk
12.	**Title: Local IoT Controller: Web-based Device Management System** **Synopsis:** This project connects ATMEGA168/328 to a relay, buzzer, and light sensor to manage multiple devices via a local web server. Users can control appliances, receive feedback from the light sensor, and get alert notifications through a web interface. It eliminates the need for external servers, ensuring quick response times within a local network. Ideal for smart home applications requiring robust local control. Sensors used: Light Sensor Actuator used: Relay, Buzzer, LED Cloud Platform: Local Web Server

13.	**Title: Wireless Switchboard: Remote Device Control using RF Communication** **Synopsis:** This project uses an RF434 MHz wireless module with ATMEGA168/328 to remotely control devices via a relay. It demonstrates basic wireless communication by sending on/off commands over a distance. Useful for home automation where remote appliance control is needed, offering a simple and effective RF-based IoT solution. Sensors used: — Actuator used: Relay Cloud Platform: —
14.	**Title: Smart Crossing Controller: Integrated Road and Railway Signal System** **Synopsis:** In this project, ATMEGA168/328 is connected to four obstacle sensors to control traffic signals at a road-railway crossing. Sensors detect approaching vehicles or trains, triggering appropriate signal changes and automated barrier controls. This system enhances safety and reduces the risk of accidents at high-risk intersections. Sensors used: Obstacle Sensor (×4) Actuator used: Traffic Signal LEDs, Servo Motor (if used for barrier) Cloud Platform: Bynk, MQTT
15.	**Title: QR-Controlled Smart Home: Automated Appliance Management** **Synopsis:** This project employs ATMEGA168/328 to control appliances (lights, fans, bulbs) via QR code scanning. By scanning a QR code, users send commands to the controller which toggles the connected devices. Combines traditional QR technology with IoT to provide secure and convenient home automation. Sensors used: QR Scanner Actuator used: Relay (for light, fan, bulb control), Buzzer, LED Cloud Platform: Blynk

16.	**Title: Smart Attendance Tracker: RFID-based Monitoring System** **Synopsis:** Using an RFID RC522 module with ATMEGA168/328, this project automates attendance for classrooms or offices. When a tag is scanned, entry is recorded and status is displayed on an LCD. Data is sent to Thing speak and Blynk for monitoring. It reduces manual errors and improves attendance management with IoT integration. Sensors used: RFID RC522 Actuator used: LCD, Buzzer, LED Cloud Platform: Thing speak, Blynk
17.	**Title: Secure Access Control: RFID-based Smart Door Lock** **Synopsis:** This project uses an RFID RC522 sensor with ATMEGA168/328 for door access. Authorized users unlock the door via RFID, which triggers a solenoid lock and updates an LCD display. Remote monitoring is available via Blynk, enhancing access security for homes and offices. Sensors used: RFID RC522 Actuator used: Solenoid Lock, LCD, Buzzer, LED Cloud Platform: Blynk, MQTT
18.	**Title: Touch-Activated Controller: MQTT-based Device Interface** **Synopsis:** ATMEGA168/328 is integrated with a touch sensor, buzzer, and relays to control devices. Touch input triggers the devices and sends real-time updates via MQTT, enabling low- latency IoT-based control. Highlights efficient use of MQTT in responsive home automation systems. Sensors used: Touch Sensor (4 switches) Actuator used: Relay, Buzzer, LED Cloud Platform: MQTT, Blynk Database: Firebase

19.	**Title: Retro Metro Switch: Automated Switch Control** **Synopsis:** This creative project repurposes a retro switch using two servo motors controlled by ATMEGA168/328. The system mimics metro-style switching and allows remote control via Blynk, enhancing traditional infrastructure. A smart approach to blending legacy tech with IoT automation. Sensors used: — Actuator used: Servo Motor (×2), LED, Buzzer Cloud Platform: Blynk, MQTT
20.	**Title: Intelligent Entry: Smart Door Security and Access Control** **Synopsis:** A PIR sensor, servo motor, and buzzer are connected to ATMEGA168/328 for door control. The PIR sensor detects motion and triggers servo-based door lock/unlock. Alerts and monitoring are enabled via Blynk, enhancing home and office entry security. Sensors used: PIR Sensor Actuator used: Servo Motor, Buzzer, LED Cloud Platform: Blynk Database: Cloud Fire base
21.	**Title: Pill Time: Smart Medication Reminder and Tracker** **Synopsis:** This project combines a Real Time Clock (RTC), LCD, and RF module with ATMEGA168/328 to remind users about their medication schedules. It displays scheduled pill times on an LCD and sends reminders via Blynk for timely medication intake. Especially beneficial in healthcare to improve adherence to prescribed routines. Sensors used: RTC Actuator used: LCD, RF Module, LED Cloud Platform: Blynk, MQTT

22.	**Title: IoT Robotic Arm: Remote Manipulation and Control** **Synopsis:** Using multiple servo motors interfaced with ATMEGA168/328, this project creates a remotely controllable robotic arm. Movements are controlled via Blynk, enabling precise automation for education, industry, or remote handling. Demonstrates effective integration of mechanics and IoT. Sensors used: — Actuator used: Servo Motors, Buzzer, LED Cloud Platform: Blynk, MQTT
23.	**Title: Smart Scale: IoT-enabled Digital Weighing System** **Synopsis:** This project uses a load cell with ATMEGA168/328 to build a digital weighing scale. Weight is displayed on an LCD and transmitted to Blynk for monitoring and analysis. Ideal for commercial or personal use, combining accuracy and IoT analytics. Sensors used: Load Cell Actuator used: LCD, LED, Buzzer Cloud Platform: Blynk, MQTT
24.	**Title: Color Sort Pro: Automated Color-based Sorting System** **Synopsis:** A color sensor attached to ATMEGA168/328 identifies object colors and sorts them accordingly. An OLED display shows the detected color, while MQTT handles cloud-based monitoring. Used in recycling or quality control for industrial automation. Sensors used: Color Sensor Actuator used: OLED, LED, Buzzer Cloud Platform: MQTT Database: Google Firebase

25.	**Title: Smart Traffic Manager: IoT-Enabled 4-Way Signal Control** **Synopsis:** This project uses an IR sensor and LEDs with ATMEGA168/328 to manage traffic at a 4- way signal. Sensors detect vehicle presence and optimize signal timing. Integration with Blynk allows remote monitoring, improving traffic flow and safety. Sensors used: IR Sensor Actuator used: LEDs, Buzzer Cloud Platform: Blynk, MQTT Database: Google Firebase
26.	**Title: Smart Assistance Stick: Multi-sensor Navigation Aid** **Synopsis:** Designed for visually impaired individuals, this ATMEGA168/328 project uses ultrasonic, fire, water, and IR sensors. Real-time alerts are sent via Blynk, assisting safe navigation. A powerful example of assistive technology using IoT. Sensors used: Ultrasonic, Fire, Water, IR Actuator used: Buzzer, LED Cloud Platform: Blynk, MQTT
27.	**Title: Smart Waste Sorter: Automated Waste Segregation System** **Synopsis:** IR sensor and servo motor with ATMEGA168/328 automatically sort waste into separate bins. Sensor data is transmitted over MQTT for remote tracking. Promotes smart recycling by reducing manual effort. Sensors used: IR Sensor Actuator used: Servo Motor, LED, Buzzer Cloud Platform: MQTT, Thing speak

28.	**Title: Washroom Sentinel: Feedback and Monitoring System** **Synopsis:** Built using ATMEGA168/328, this project collects user feedback via a switch and displays it on an LCD. Data is logged and can be analyzed via Blynk or exported to Excel. Helps maintain public hygiene by analyzing satisfaction levels. Sensors used: Switch Actuator used: LCD, Buzzer, LED Cloud Platform: Blynk Database Google Firebase
29.	**Title: Fire Guard Pro: Automated Fire and Temperature Alert System** **Synopsis:** Fire and temperature sensors are connected to ATMEGA168/328 to continuously monitor safety conditions. When thresholds are exceeded, alerts are sent via SMTP email (HTML/text/attachments). Excellent for proactive safety in industrial and residential spaces. Sensors used: Fire Sensor, Temperature Sensor Actuator used: Buzzer, LED Cloud Platform: SMTP (Email Notifications)
30.	**Title: Door Watch: Real-Time Door Status Monitoring with Telegram Alerts** **Synopsis:** This project uses ATMEGA168/328 with door sensors to monitor and send alerts via Telegram. Notifies users instantly of door access or breaches, and logs the data for review. Enhances home and office security using messaging platforms. Sensors used: Magnetic Door Sensor Actuator used: Buzzer, LED Cloud Platform: Telegram

31.	**Title: Motion Sense Hub: Comprehensive Inertial and Temperature Monitoring** **Synopsis:** Combines MPU-6050 (accelerometer, gyroscope) with ATMEGA168/328 to monitor motion and temperature. Data is displayed in Blynk and Thing speak dashboards. Ideal for asset tracking, movement analysis, and safety monitoring. Sensors used: MPU-6050 Actuator used: LED, Buzzer Cloud Platform: Blynk, Thing speak
32.	**Title: Cloud BME: Real-time Environmental Monitoring with BME280** **Synopsis:** BME280 sensor with ATMEGA168/328 monitors temperature, pressure, and humidity. Data is sent to a real-time cloud database for access via mobile/web dashboard. Triggers alerts on deviations, useful for both home and industry. Sensors used: BME280 Actuator used: LED, Buzzer Cloud Platform: Real-time Database
33.	**Title: Farm Sense Secure: Firebase-Integrated Sensor Dashboard** **Synopsis:** ATMEGA168/328 with DS18B20 temperature sensor and soil moisture sensor sends data to Firebase. Secure web dashboard with Firebase authentication allows only authorized access. Ideal for smart farming and remote environment monitoring. Sensors used: DS18B20, Soil Moisture Sensor Actuator used: Buzzer, LED Cloud Platform: Bynk, Thing speak Database: Firebase

34.	**Title: Smart Energy Meter / Smart Grid System** **Synopsis:** This project utilizes ATMEGA168/328 integrated with a ZMPT101B voltage sensor and an ACS712 current sensor to measure real-time voltage and current from the electrical supply. The measured data is processed to calculate power consumption, which is displayed locally on an OLED display. For remote monitoring and analytics, the data is sent to Blynk, Thingspeak, and stored in Firebase as a real-time database. The system helps in monitoring energy usage, detecting overloads or abnormal consumption patterns, and promotes efficient energy management in homes or industries. It also supports grid-level applications where power quality and usage data from multiple locations can be aggregated and analyzed. Sensors used: ZMPT101B (Voltage Sensor), ACS712 (Current Sensor) Actuator used: OLED Display, LED, Buzzer Cloud Platform: Blynk, Thing speak Database: Firebase
35.	**Title: Smart Health Monitor: Pulse Rate, Heartbeat & Oxygen Level Tracking** **System Synopsis:** This project is based on ATMEGA328 and integrates biomedical sensors to measure pulse rate, heart rate, and SpO_2 (oxygen saturation) levels. The real-time health data is displayed on an OLED screen, and abnormal values trigger alerts via a buzzer and LED indicator. For remote health tracking and data logging, the readings are uploaded to Blynk, Thing speak, and Firebase Real-time Database. This system is particularly useful for home healthcare, elderly monitoring, and telemedicine, allowing patients and doctors to monitor vitals remotely with real-time alerts. It ensures timely awareness of critical health changes and supports emergency response. Sensors used: Pulse Sensor (or MAX30100/MAX30102 for heart rate & SpO_2) Actuator used: OLED Display, Buzzer, LED Cloud Platform: Blynk, Thing speak Database: Firebase (Real-time Database)

R-2025- S.E All Branches

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned					Total Credits (C)
		L	T	P	L	T	P	SL	Notional Learning Hour	(Notional Learning Hour/30
98451410	Design Thinking	2	-	-	30		-	30	60	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total.					
98451410	Design Thinking	20	20	40	60	2.5	--	--	100

Rationale :

Design Thinking is a human-centered approach that fosters creativity, empathy, and problem-solving. This course equips students with tools to understand user needs, generate innovative ideas, and develop practical solutions for real-world challenges.

Course Objectives:

1. Introduce the core principles and stages of the Design Thinking process.
2. Develop an empathetic mindset to understand user needs.
3. Frame clear problem statements using user-centered tools.
4. Apply ideation techniques to generate creative solutions.

5. Understand various types of prototypes and their role in product development.
6. Learn the process of testing and refining ideas based on feedback.

Course Outcomes:

On successful completion of the course learner will be able to:

1. Compare traditional and design thinking-based approaches to problem solving.
2. Define user personas using empathy and mapping techniques.
3. Frame actionable problem statements using POV and problem definition tools.
4. Apply ideation techniques to develop diverse solution sets.
5. Differentiate between low and high-fidelity prototypes and understand their usage.
6. Explain how to test prototypes based on desirability, feasibility, and usability..

Prerequisite: Fundamentals of communication and leadership skills.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite**	Fundamentals of communication and leadership skills		
I	**Introduction to Design Thinking**	**Introduction to Design Thinking:** Definition, Comparison of Design Thinking and traditional problem-solving approach, Need for Design Thinking approach, Key tenets of Design Thinking, 5 stages of Design Thinking (Empathize, Define, Ideate, Prototype, Test)	4	CO1

		Self-learning Topics: Design thinking case studies from various domains. **Link:** https://www.design-thinking-association.org/explore-design-thinking-topics/external-links/design-thinking-case-study-index	4	
II	**Empathy**	Foundation of empathy, Purpose of empathy, Observation for empathy, User observation technique, Creation of empathy map.	5	CO2
		Self-learning Topics: Creation of empathy maps **Link:** https://www.interaction-design.org/literature/topics/empathy-mapping **Case Study:** Designing MRI for Children – GE Healthcare	5	
III	**Define**	Significance of defining a problem, Rules of prioritizing problem solving, Conditions for robust problem framing, Problem statement and POV	5	CO3
		Self-learning Topics: Creating a Persona – A step-by-step guide with tips and examples **Link:** https://uxpressia.com/blog/how-to-create-persona-guide-examples	5	
IV	**IIdeate**	What is ideation? Need for ideation, Ideation techniques,	6	CO4

		Guidelines for ideation: Multi-disciplinary approach, Imitating with grace, Breaking patterns, Challenging assumptions, Looking across value chain, Looking beyond recommendation, Techniques for ideation: Brainstorming, Mind mapping		
		Self-learning Topics: How To Run an Effective Ideation Workshop: A Step-By-Step Guide **Link:** https://uxplanet.org/how-to-run-an-effective-ideation-workshop-a-step-by-step-guide- d520e41b1b96	6	
V	**Prototype**	Low and high-fidelity prototypes, Paper prototype, Story board prototype, Scenario Prototype.	4	CO5
		Self-learning Topics: IDEO Prototyping Toolkit	4	
VI	**Test**	5 guidelines of conducting test, The end goals of test: Desirability, Feasibility and Viability, Usability testing	6	CO6
		Self-learning Topics: Real-world Testing Examples from Stanford d.school or IDEO **Case Study:** IDEO's Shopping Cart Redesign – A classic innovation sprint (All stages)	6	

Total		30	

Textbooks:

1. Design Your Thinking: The Mindsets, Toolsets, and Skill Sets for Creative Problem-solving, Pavan Soni, Penguin, Random House India Private Limited
2. Design Thinking: Methodology Book, Emrah Yayichi, 2016
3. Handbook of Design Thinking: Christian Mueller-Roterberg, 2018

Reference books:

1. Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School, Idris Mootee, Wiley, 2013
2. Change by Design, Tim Brown, Harper Business, 2009

Online References:

Sr. No.	Website Name
1.	Design Thinking and Innovation by Ravi Poovaiah https://onlinecourses.swayam2.ac.in/aic23_ge17/preview
2.	Introduction to Design Thinking by Dr. Rajeshwari Patil, Dr. Manisha Shukla, Dr Deepali Raheja, Dr. Mansi Kapoor https://onlinecourses.swayam2.ac.in/imb24_mg37/preview
3.	Usability Testing https://www.interaction-design.org/literature/topics/usability-testing

R-2025- S.E All Branches

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned					Total Credits (C) (Notional Learning Hour/30
		L	T	P	L	T	P	SL	Notional Learning Hour	
98431411	**Business Model Development**	2	-	-	30		-	30	60	**2**

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
98431411	**Business Model Development**	--	--	--	--	--	25	--	25

Rationale :

Entrepreneurship is the backbone of innovation and economic growth. In the 21st-century knowledge economy, students must be equipped not just with employment-ready skills but with a problem-solving and innovation mindset to become job creators. This course blends core entrepreneurship principles with business model design, startup financing, and digital business strategies.

Course Objectives:

1. To introduce students to entrepreneurship and its socio-economic relevance.

2. To enable understanding of different business structures and MSME significance.
3. To familiarize learners with funding mechanisms for startups.
4. To introduce the basics of IPR and ethical innovation practices.
5. To equip students with tools for building business models and MVPs.
6. To explore digital marketing and disruption in online business ecosystems.

Course Outcomes:

On successful completion of the course learner will be able to:

1. Define and explain entrepreneurship and its key types.
2. Analyze the legal and operational structure of business ownership.
3. Identify and compare startup funding models and sources.
4. Apply the fundamentals of IPR to protect entrepreneurial innovations.
5. Create comprehensive business models using BMC tools.
6. Evaluate and apply digital marketing techniques for online business models.

Prerequisite: Basic Design Thinking principles.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite**	Basic Design Thinking principles		
I	**Introduction to Entrepreneurship**	Definition, the role of entrepreneurship in the economic development, The entrepreneurial process, Women entrepreneurs, Corporate entrepreneurship, Entrepreneurial mindset.	5	CO1
		Self-learning Topics: Case studies: Henry Ford https://www.thehenryford.org/docs/default-	5	

		source/default-document-library/ default- document-library/henryfordandinnovation.pdf?sfvrsn=0 The Tatas: How a Family Built a Business and a Nation by Girish Kuber, April 2019, Harper Business		
II	**Entrepreneurship Development**	Types of business ownerships: Proprietorship, Public and Private Companies, Co-operative businesses, Micro, Small and Medium Enterprises (MSME): Definition and role of MSMEs in economic development.	4	CO2
		Self-learning Topics:MSME Act and Udyam Registration portal **Case Study:** Amul – Co-operative innovation in dairy sector	4	
III	**Start-up financing**	**Start-up financing:** Cost and revenue models, Sources of start-up fundings: Angel investors, Venture capitalists, Crowd funding, Government schemes funding(e.g., SIDBI, Startup India).	5	CO3
		Self-learning Topics: Successful business pitching. **Case Study:** Shark Tank pitch breakdown.	5	
IV	**Intellectual Property Rights (IPR)**	Types of IPR: Patents, trademarks and copyrights, Patent search and analysis, Strategies for IPR protection, Ethics in technology and innovation.	5	CO4

		Self-learning Topics: Case Study: WIPO Patent Search Exercise	5	
V	**Business Model Development**	Types of business models, Value proposition, Customer segments, Customer relationships, Channels, Key partners, Key activities, Key resources, Prototyping and MVP.	6	CO5
		Self-learning Topics: The Art of the Start 2.0: The Time-Tested, Battle- Hardened Guide for Anyone Starting Anything by Guy Kawasaki **Case Study:** The Rise of Zomato – A Disruptive Food Delivery Platform	6	
VI	**Digital Business Management**	Digital Business models (Subscription, Freemium *etc*), Digital marketing: Search Engine Optimization (SEO), Search Engine Marketing (SEM), Social media and influencer marketing, Disruption and innovation in digital business.	5	CO6
		Self-learning Topics: Case study: Airbnb https://www.prismetric.com/airbnb-business-m	5	
Total			30	

Sr No	List of Assignments	Hrs
01	Presentation on case study of a failed business model	2

02	Presentation on case study of a woman entrepreneur	2

Textbooks:

1. Entrepreneurship: David A. Kirby, McGraw Hill, 2002
2. Harvard Business Review: Entrepreneurs Handbook, HBR Press, 2018
3. Business Model Generation; Alexander Ostlewalder and Yves Pigneur, Strategyzer, 2010
4. E- Business & E– Commerce Management: Strategy, Implementation, Practice – Dave Chaffey, Pearson Education

Reference books:

1. Entrepreneurship: New venture creation by David Holt, Prentice Hall of India Pvt. Ltd.
2. E- Business & E– Commerce Management: Strategy, Implementation, Practice – Dave Chaffey, Pearson Education

Online References:

Sr. No.	Website Name
1.	Startup India Portal – https://www.startupindia.gov.in
2.	Entrepreneurship by Prof. C Bhaktavatsala Rao https://onlinecourses.nptel.ac.in/noc20_mg35/preview
3.	Innovation, Business Models and Entrepreneurship by Prof. Rajat Agrawal, Prof. Vinay Sharma https://onlinecourses.nptel.ac.in/noc21_mg63/preview
4.	Sarasvathy's principles for effectuation https://innovationenglish.sites.ku.dk/model/sarasvathy-effectuation/
5.	WIPO Patent Search https://www.wipo.int/portal/en/index.html
6.	Airbnb Business Model Case https://www.prismetric.com/airbnb-business-model/

7.	BMC Tool https://www.strategyzer.com/canvas/business-model-canvas

Assessment:

Term Work: Term Work shall consist of at least 4 to 5 **Case Study Analysis , Presentation** based on the above list. Also, Term work Journal must include at least 2 to 3 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Case Study report)+ 5 Marks (Assignments) + 5 Marks (Attendance).

5. T.E Syllabus

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC501	Digital communication	03	--	--	03	--	--	03

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC501	Digital communication	20	20	40	60	2.5	--	--	100

Rationale :

Digital Communication is essential for understanding how data is transmitted, processed, and secured in modern electronic systems. It forms the backbone of technologies like mobile networks, the internet, and satellite communication. This subject equips students with the skills to design efficient, reliable, and high-speed communication systems, aligning with current industry needs and future advancements in wireless and digital technologies.

Course Objectives:

1. Analyze the fundamental principles of information theory and source coding for efficient data transmission.
2. Design and evaluate various error control codes to ensure reliable communication in diverse environments.
3. Design, implement, and evaluate different channel coding techniques
4. Develop and optimize baseband systems for robust digital signal transmission.
5. Evaluate the performance of optimum baseband detection in the presence of white noise
6. Compare different digital modulation and demodulation techniques

Course Outcomes:

After successful completion of the course student will be able to:

1. Apply the concepts of information theory in source coding.
2. Compare different error control systems and apply various error detection codes.
3. Design, implement, and evaluate different channel coding techniques.
4. Compare various baseband transmission methods for digital signals.
5. Evaluate the performance of optimum baseband detection in the presence of white noise.
6. Evaluate the performances of different digital modulation techniques

Prerequisite:

1) Mathematics for Signal Analysis
2) Electronic Devices & Linear Circuits
3) Analog and Digital Communication

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Information Theory and Source Codes**	1.1 Block diagram of digital communication system, Information content of a source symbol, Source entropy, Average information rate, AWGN channel, and Shannon Hartley channel capacity theorem. 1.2 Introduction of source code, Huffman code, Shannon-Fano code.	5	CO1
II	**Error Control System and Error Detection Codes**	2.1 Introduction of error control system, Automatic Retransmission Query (ARQ) system, Types of ARQ systems and comparison, Forward error correction (FEC) system. Comparison between FEC and ARQ.	3	CO2

III	**Error Correction Codes**	3.1 Linear block code: Code generation, calculation of minimum Hamming distance, error detection capability, error correction capability, implementation of encoder, error detection, syndrome table, error correction and implementation of decoder. 3.2 Cyclic code: Code generation, calculation of minimum Hamming distance, error detection capability, error correction capability, implementation of encoder, error detection, syndrome table, error correction and implementation of decoder. 3.3 Convolutional code: Generation, path responses, encoder, state transition table, state diagram, tree diagram, trellis diagram, decoding using Viterbi's algorithm.	10	CO3
VI	**Baseband Transmission**	4.1 Block diagram of a baseband transmitter-receiver system. Line codes (RZ and NRZ UniPolar, RZ and NRZ Polar, NRZ Bipolar (AMI), NRZ Manchester, Quaternary Polar formats).Compare line codes with respect to bandwidth, power requirement, synchronization capability, DC level, polarity inversion error, and complexity: Optimize line code selection for energy-efficient data transmission in wired communication systems.Power spectral density and spectrum of NRZ Unipolar and Polar formats. 4.2 Inter Symbol Interference (ISI), Inter Channel Interference (ICI). Nyquist criterion for distortionless baseband binary transmission, Nyquist bandwidth and practical bandwidth	5	CO4
V	**Optimum Detection of Baseband Signal**	5.1 Matched filter: Output SNR, Transfer function, Impulse response, and Error probability. Integrate and dump receiver, Correlator receiver. Evaluate the performance of optimum baseband detection techniques in the presence of Additive White Gaussian Noise (AWGN), and propose methods	4	CO5

		to improve signal-to-noise ratio for robust communication.		
VI	**Digital Modulations**	6.1 Generation, Detection, Error probability (using signal space representation and Euclidean distance), Bandwidth (using PSD and spectrum except for MSK), and applications of the following modulations: Binary ASK, Binary PSK, Quadrature PSK, Off-Set QPSK, M-ary PSK, Binary FSK, M-ary FSK, 16-ary QASK, and MSK. 6.2 Evaluate their spectral efficiency and power efficiency, and discuss their environmental impact.	12	CO6

Text Books:

1.H. Taub, D. Schlling, and G. Saha-Principles of Communication Systems, Tata Mc-Graw Hill, New Delhi, Third Edition, 2012.

2. Lathi B P, and Ding Z-Modern Digital and Analog Communication Systems, Oxford University Press, Fourth Edition, 2017.

3. Haykin Simon-Digital Communications, John Wiley and Sons, New Delhi, Fourth Edition, 2014.

4. John G. Proakis-Digital Communications, McGraw-Hill, Fourth Edition

References:

1. Sklar B, and Ray P. K.-Digital Communication: Fundamentals and applications, Pearson,Dorling Kindersley (India), Delhi, Second Edition, 2009.

2. T L Singal-Analog and Digital Communication, Tata Mc-Graw Hill, New Delhi, First Edition,2012.

3. P Ramakrishna Rao-Digital Communication, Tata Mc-Graw Hill, New Delhi, First Edition,2011.

4. K. Sam Shanmugam-Digital and analog communication Systems, John Wiley and sons. 5. Upamanyu Madhow- Fundamentals of Digital Communication- Cambridge University Press 6. W.C. Huffman, Vera Pless- Fundamentals of Error Correcting Codes, Cambridge University Press

7. Graham Wade-Coding Techniques, Palgrave, New York

Online References:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/108/101/108101113/
2.	https://nptel.ac.in/courses/108/102/108102096/
3.	https://nptel.ac.in/courses/108/102/108102120/

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Pract.	Tut.	Total
ETC502	Discrete Time Signal Processing	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC502	Discrete Time Signal Processing	20	20	40	60	2.5	--	--	100

Rationale:

This course is designed to provide students with an in-depth understanding of digital signal processing (DSP) techniques and their applications. Emphasis is placed on the analysis and design of IIR and FIR filters, frequency transformations, FFT algorithms, and the impact of finite word-length effects in digital systems. Students will gain both theoretical insights and practical experience, enabling them to apply DSP techniques to real-world problems in biomedical, speech, and communication systems.

Course Objectives:

1. To introduce the fundamentals and mathematical foundations of the Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT) algorithms.
2. To design and analyze IIR digital filters using various transformation techniques from analog filters.
3. To develop FIR digital filters using windowing and frequency sampling techniques, and compare their characteristics with IIR filters.
4. To explore various digital filter structures and evaluate their computational complexity and realization methods.
5. To understand and analyze the effects of finite word length on digital filters, including quantization errors and limit cycles.
6. To expose students to practical DSP applications in biomedical signal processing and speech enhancement.

Course Outcomes:

After successful completion of the course student will be able to:

1. Apply DFT and FFT techniques for spectral analysis and filtering of long data sequences.
2. Implement and analyze IIR digital filters using impulse invariant and bilinear transformation techniques.
3. Design FIR digital filters using windowing and frequency sampling methods.
4. Realize and compare various digital filter structures for efficient implementation.
5. Analyze the effect of finite word length on digital filter performance and understand error sources in DSP systems.
6. Apply DSP techniques for processing ECG, EEG, and speech signals in real-world applications.

Prerequisite:

1) Mathematics for Signal Analysis

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping

0	**Prerequisite**	Basics of discrete-time signals and systems,Concepts of convolution and correlation ,Z-transform and its properties,Fourier series and Fourier transform (CT and DT),Basic linear algebra and complex number operations	01	
I	**Discrete Fourier Transform & Fast Fourier Transform**	1.1 Discrete Fourier transform (DFT), DFT as a linear transformation, Properties of the DFT, Relationship of the DFT to other transforms, Filtering of long data sequences:Overlap-Save and Overlap-Add Method 1.2 Fast Fourier Transform: Radix-2 Fast Fourier Transforms (FFT), Radix-2 decimation in time and decimation in frequency FFT algorithms, Inverse FFT	08	CO1
II	**IIR Digital filters**	2.1 LTI systems as frequency-selective filters like low pass, high pass, band pass, notch, comb, all-pass filters, and digital resonators, Analog filter approximations: Butterworth, Chebyshev I, Elliptic 2.2 Mapping from s-plane to the z-plane - impulse invariant and bilinear transformation, Design of IIR digital filters (Butterworth and Chebyshev-I) from analog filters using impulse invariant and bilinear transformation techniques, Analog and digital frequency transformations	08	CO2
III	**FIR Digital Filters**	3.1 Characteristics of linear phase FIR digital filters, Symmetric and antisymmetric FIR filter, Location of the zeros of linear phase FIR filters, Minimum, maximum and mixed phase systems	09	CO3

		3.2 Design of FIR filters using Window techniques (Rectangular, Hamming, Hanning, Blackman, Bartlett), Design of FIR filters using Frequency Sampling Technique –Type I low pass filter design, Comparison of IIR and FIR filters		
IV	**Digital Filter Structures**	4.1 Realization structures for FIR systems: Cascade form, Frequency sampling structure, Lattice structure, Computational complexities for N length filter 4.2 Realization structures for IIR systems: Cascade form and parallel form structures, Lattice Ladder structure, Computational complexities for N order filter	05	CO4
V	**Finite Word Length Effects in Digital Filters**	5.1 Rounding and truncation errors, Quantization error, Output noise power from a digital system 5.2 Product quantization, Noise model for direct form and cascaded IIR structure (first order), Coefficient quantization error and zero input limit cycle	05	CO5
VI	**Applications of Digital Signal Processing**	6.1 Application of DSP for ECG and EEG signals analysis. 6.2 Application of DSP for echo cancellation and sub-band coding of speech signal	04	CO6

Text Books:

1. Proakis J., Manolakis D., "Digital Signal Processing", 4th Edition, Pearson Education.
2. Emmanuel C. Ifeachor, Barrie W. Jervis," Digital Signal Processing", A Practical Approach", Pearson Education

3. A Nagoor Kani “Digital Signal Processing”, 2nd Edition. Tata Mc Graw Hill Education Private Limited

Reference books

1. Sanjit K. Mitra, “Digital Signal Processing – A Computer Based Approach “, 4th Edition McGraw Hill Education (India) Private Limited, 2013
2. Oppenheim A., Schafer R., Buck J., "Discrete Time Signal Processing", 2nd Edition, Pearson Education, 3rd Edition, 2010
3. L. R. Rabiner and B. Gold, “Theory and Applications of Digital Signal Processing”, Prentice-
Hall of India, 2006.
4. S Salivahan, C Gnanapriya, “Digital Signal Processing”, Mc Graw Hill Education (India) limited, 4th Edition, 2015
5. Monson H Hayes, “Digital Signal Processing”, Schaum’s Outline Series, 2nd Edition, 2011
6. Rangaraj M. Rangayyan, “Biomedical Signal Analysis- A Case Study Approach”,Wiley 2002.

Online References: NPTEL / Swayam Course:

Sr. No.	Website Name
1.	Course: Digital Signal Processing By Prof. S.C Dutta Roy, IIT Delhi http://www.nptelvideos.in/2012/12/digital-signal-processing.html
2.	Course: Digital Signal Processing By Prof. S.C Dutta Roy, IIT Delhi http://www.nptelvideos.in/2012/12/digital-signal-processing.html
3.	Course: Digital Signal Processing By Prof. T. K. Basu , IIT Kharagpur https://nptel.ac.in/courses/108/105/108105055/

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC503	Digital VLSI	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC503	Digital VLSI	20	20	40	60	2.5	--	--	100

Rationale:

Digital VLSI (Very Large Scale Integration) is essential for designing and implementing high-performance, low-power digital systems used in modern electronics. This subject equips students with foundational knowledge and practical skills in digital circuit design, layout, and fabrication processes, preparing them for careers in semiconductor design, embedded systems, and advanced computing technologies.

Course Objectives:

1. To introduce the process flow of VLSI Design.
2. To understand MOSFET operation from VLSI design perspective.
3. To learn VLSI design performance metric and various tradeoffs.
4. To design, implement and verify combinational and sequential logic circuits using various MOS design styles.
5. To provide an exposure to RTL design and programming.
6. To gain practical exposure to VLSI design tools and methodologies, including

simulation, synthesis, and physical design, facilitating the transition from theoretical concepts to real-world applications.

Course Outcomes:

1. Know various tools and processes used in VLSI Design.
2. Explain working of various CMOS combinational and sequential circuits used in VLSI Design.
3. Derive expressions for performance parameters of basic building blocks like CMOS inverter.
4. Relate performance parameters with design parameters of VLSI circuits.
5. Select suitable circuit and design style for given application.
6. Design and realize various combinational and sequential circuits for given specifications.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
1	Review of MOSFET operation and Fabrication	1.1 Overview of VLSI Design Flow, Review of MOSFET operation, MOSFET Capacitances, MOSFET scaling, Short channel effects. 1.2 Fabrication process flow of NMOS and CMOS, Lambda based design rules. 1.3 Novel MOSFET Architectures FinFET, GAA-FET, CNTFET.	08	CO1
2	Combinational CMOS Logic Circuits	2.1 CMOS inverter operation, Voltage Transfer characteristics (VTC), Noise Margins, Propagation Delay, Power Dissipation, Design of CMOS Inverter, Layout of CMOS Inverter 2.2 Realization of CMOS NAND gate, NOR gate, Complex CMOS	06	CO2

		Logic Circuits, Layout of CMOS NAND, NOR and complex CMOS circuits		
3	MOS Design Logic Styles	3.1 Static CMOS, Pass Transistor Logic, Transmission Gate, Pseudo NMOS, Dynamic Logic, Domino Logic, NORA, Zipper, C2MOS 3.2 Setup time, Hold time, clocked CMOS SR Latch, CMOS JK Latch, MS –JK Flip Flop, Edge triggered D-Flip Flop and realization using design styles. 3.3 Realization of Shift Register, MUX, Decoder using above design styles, 1-bit full adder.	09	CO3
4	Semiconductor Memories	4.1 ROM array, 6T-SRAM (operation, design strategy, leakage currents, sense amplifier), layout of SRAM 4.2 Operation of 1T and 3T DRAM Cell, NAND and NOR flash memory	06	CO4
5	Data path and system design issues	5.1 Ripple carry adder, CLA adder, carry save adder, carry select adder, carry skip adder, Array Multiplier 5.2 On chip clock generation and distribution, Interconnect delay model, interconnect scaling and crosstalk	06	CO5
6	RTL Design	6.1 High Level state machines, RTL design process 6.2 RTL design of Soda dispenser machine, FIR Filter	04	CO6

Textbooks:

1. Sung-Mo Kang and Yusuf Leblebici, “CMOS Digital Integrated Circuits Analysis and Design”, Tata McGraw Hill, 3rd Edition, 2012.
2. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, “Digital Integrated Circuits: A Design Perspective”, Pearson Education, 2nd Edition.

3. Frank Vahid, "Digital Design with RTL design, VHDL and VERILOG", John Wiley and Sons Publisher 2011.

Reference Books

1. Neil H. E. Weste, David Harris and Ayan Banerjee, ―*CMOS VLSI Design: A Circuits and Systems Perspective*‖, Pearson Education, 3rd Edition.
2. John P. Uyemura, "*Introduction to VLSI Circuits and Systems*", Wiley, Student Edition, 2013.
3. R. Jacob Baker, "*CMOS Circuit Design, Layout and Simulation*", Wiley, 2nd Edition, 2013

Online References:

Sr. No.	Website Name
1.	https://onlinecourses.nptel.ac.in/noc21_ee09/preview
2.	https://nptel.ac.in/courses/108107129
3.	https://archive.nptel.ac.in/courses/117/105/117105137/

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC504	Random Signal Analysis	3	-	01	3	-	1	4

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC504	Random Signal Analysis	20	20	40	60	2.5	25	--	125

Rationale:

The course equips students with essential mathematical and statistical tools to model, analyze, and interpret signals and systems affected by uncertainty and noise. It lays a strong foundation in probability theory, random variables, and stochastic processes—crucial for understanding real-world systems in communication, control, and signal processing. Through the study of distributions, random processes, and linear regression, students gain the ability to predict, analyze, and optimize system performance in uncertain environments. This course bridges theoretical concepts with practical applications, preparing students for advanced studies and innovations in areas like wireless communication, data analytics, and machine learning.

Course Objectives:

1. To strengthen the foundations of probability
2. To teach continuous and discrete random variables.

3. To explain statistical behavior of one dimensional and two dimensional random variables.
4. To describe the concept of random process which is essential for random signals and systems encountered in Communications and statistical learning.
5. To develop problem solving skills and explain how to make the transition from a real world problem to a probabilistic model.

Course Outcomes:

After successful completion of the course student will be able to:

1. Apply theory of probability in identifying and solving relevant problems.
2. Differentiate continuous and discrete random variables and their distributions.
3. Analyze mean, variance, and distribution function of random variables and functions of random variables.
4. Analyze and characterize systems involving multiple random variables, calculate their joint statistics, and explain the significance of the Central Limit Theorem.
5. Define a random process, determine the type of the process and find the response of LTI system for WSS process.
6. Explain linear regression algorithms and apply for predictive applications.

Prerequisite:

1. Engineering Mathematics IV
2. Signals and Systems

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Basic Concepts in Probability**	1.1 Definitions of probability, joint, conditional, and total probability, Bayes' theorem, independence of events, binary symmetric communication channel analysis using Bayes' theorem.	04	CO1
II	**Introduction to Random Variables**	2.1 Continuous, discrete, and mixed random variables, probability density function, probability distribution function, and	8	CO2

		probability mass function, properties of PDF and CDF 2.2 Special distributions- Binomial, Poisson, Uniform, Gaussian and Rayleigh Distributions Mean, variance and moments of random variables		
III	**Operations on One Random Variable**	3.1 Function of a random variable and their distribution and density functions. 3.2 Expectation, variance, moments, and characteristic function of random variable. 3.3 Transformation of a random variable, Markov and Chebyshev inequality, characteristic functions, moment theorem.	8	CO3
IV	**Multiple Random Variables and Convergence**	4.1 Pairs of random variables, joint CDF and joint PDF. 4.2 One function of two random variables; joint moments, covariance and correlation-independent, uncorrelated and orthogonal random variables. 4.3 Central limit theorem and its significance	8	CO4
V	**Random Processes**	5.1 Definitions, statistics of stochastic processes, n^{th} order distribution, second-order properties: mean and autocorrelation, Poisson process, normal processes, SSS, WSS. 5.2 Mean and correlation ergodic processes, transmission of WSS through LTI system, introduction to Markov process.	6	CO5
VI	**Introduction to Statistical Learning and Applications**	6.1 Regression and model building, simple linear regression, multiple linear regression, least square estimation of the coefficients, residual calculations. 6.2 Applications of simple linear regression in prediction of new observations. **Self-learning Topics:** More applications on algorithms used for signal processing	5	CO6

Text Books:

1. T. Veerarajan, "Probability, Statistics and Random Process", Tata McGraw Hill Education, Third Edition (2018).
2. Athanasios Papoulis and S. Unnikrishna Pillai, "Probability, Random Variables, and Stochastic Processes", Tata McGraw Hill Education
3. Henry Stark & John Woods, "Probability, Statistics, and Random Processes for Engineers, 4th Edition, Pearson Education, 2012
4. Douglas C. Montgomery, Elizabeth A. Peck and G. Geoffrey Vining, "Introduction to linear regression Analysis", student edition, Wiley publications.

References:

1. Scott Miller and Donald Childers, "Probability and Random Processes with Applications to Signal Processing and Communications", Elsevier Publication.
2. Hwei Hsu, "Theory and Problems of Probability, Random Variables, and Random Processes", Schaum's Outline Series, McGraw Hill, 1997.
3. P. Ramesh Babu, "Probability Theory and Random Process", Tata McGraw Hill Education.
4. Alberto Leon Garcia, "Probability and Random Processes for Electrical Engineering", second edition , Pearson education.
5. Daniela Witten, Trevor Hastie , Robert Tibshirani, "An Introduction to Statistical Learning by Gareth James", 7th Edition, Springer 2017.
6. Ronald Walpole, et. al., "Probability and Statistics for Engineers and Scientists", 8th edition, Pearson Education.
7. P. Kousalya, "Probability, Statistics, and Random Processes", Pearson Education.

Online References

Sr. No.	Website Name
1.	Introduction to probability and Statistics, Prof. G. Srinivasan (IITMadras); https://onlinecourses.nptel.ac.in/noc21_ma01/preview
2.	Probability and Probability Distributions By Dr. P.Nagesh: https://onlinecourses.swayam2.ac.in/cec21_ma02/preview

Assessment:

Term Work (25-Marks):

At least 08 Tutorials covering entire syllabus must be given during the "Class Wise Tutorial". Term work assessment must be based on the overall performance of the student with every tutorial graded from time to time. The grades will be converted to marks as per "Credit and Grading System" manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC551	Digital and IP TV Engineering	03	--	--	03	--	--	03

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC551	Digital and IP TV Engineering	20	20	40	60	2.5	--	--	100

Rationale:

Digital and IP TV Engineering focuses on the technologies and standards used in the delivery of high-quality multimedia content over digital and IP-based networks. This subject equips students with knowledge of video compression, streaming protocols, content distribution, and interactive services. As the demand for smart broadcasting, OTT platforms, and IPTV grows, this course prepares students to design and manage next-generation television systems, aligning with modern industry trends in digital media and communication.

Course Objectives:

1. To provide in depth knowledge about Digital Television system
2. To familiarize students' various types of advanced types of Video cameras and Displays
3. To introduce the students to different television standards and applications Acquaintance with HDTV and 3D TV system

4. To familiarize the students to IPTV, Its architecture, Protocols and hardware
5. To Introduce students to IP delivery networks, threats and mitigation

Course Outcomes:

1) Understand the working principles of advanced digital television systems.
2) Enable to choose or develop an appropriate camcorder and displays based on applications.
3) Familiar with current digital TV standards.
4) Evaluate the Stereoscopic images and binocular depth perception.
5) Acquire knowledge of IPTV and develop hardware and protocols.
6) Ability to provide customized IPTV services to end user.

Prerequisite:

1. Basics of various Television standards and operation
2. TCP/IP Protocol
3. Basics of conventional video camera and standards

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Fundamentals of Digital Television**	1.1 Fundamentals of colour television, Compatibility, and reverse compatibility, colour perception, Three colour theory, luminance, hue and saturation. Interlaced scanning, Composite video signal,Introduction to Digital TV, Digital TV signals and parameters 1.2 Digital TV transmitter and Receiver its merits and demerits 1.3 MAC Signals and advanced MAC Signal Transmission 1.4 Digitization, Chroma sub sampling, Digital audio compression	7	CO1

		techniques and video compression techniques MPEG1,MPEG2,H.264,MPEG-4,AVC,H.265, SMPTE 421M 1.5 Set Top Box with recording		
II	**Digital Video Cameras, Displays and Streaming media device**	2.1 Colour TV Digital cameras, Camcorders, Handycams, and Digicams 2.2 LED, LCD, OLED, PLASMA, Quantum Dot LED Displays 2.3 Chromecast Consumer applications: DVD, Blue ray DVD	5	CO2
III	**Digital TV standards and advanced TV**	DVB-T, and its successors ISDB -T,ATSC,ISD TV,DTMB,Ultra HDTV,CCTV,Direct to Home TV(DTH),Smart TV and its functions,3D TV,Direct to Home TV(DTH),Smart TV and its functions,3D TV	8	CO3
IV	**IPTV**	Introduction to IPTV,IP TV hardware,Features of IPTV,Architecture of IPTV,Bandwidth requirement,IPTV Set top Box, Smart TV comparison	6	CO4
V	**IP TV Protocols and Applications**	Internet Group Management Protocol (IGMP),Real-Time Streaming Protocol (RTSP),Real-Time Messaging Protocol (RTMP),Hypertext Transfer Protocol (HTTP).Applications of IPTV,IPTV Delivery: Broad cast. Unicast, Multicast,IPTV Streaming: Time Shifted Stream-On -the- fly streaming,experimental framework used for evaluating the classification algorithm,Experimental framework for evaluating the classification algorithm (Self learning) Configuring IPTV to android phone, Tablet, Television and Computer (Self Learning)	9	CO5

VI	**IPTV Network Security: Threats and Countermeasures**	Threats on IPTV Delivery Networks, Theft or Abuse of Network Assets, Theft of Service, Theft of IPTV-Related Data, Disruption of Service, Privacy Breach, Compromise of Platform Integrity. Security Issues of IPTV Delivery Networks: Protocols Vulnerabilities, Countering the threats,Advantages and disadvantages of IPTV,Future of IPTV	4	CO6

Text Books:

1. Television and video Engineering, A. M. Dhake, Tata McGraw Hill Publication.
2. Video Demystified, Kelth jack, Hand book for digital engineers, Newness, Elsevier
3. Digital Television Systems. Marcelo S. Alencar, Cambridge University Press
4. Understanding IPTV, Gilbert Held, CRC Press

Reference Books:

1. The digital evolution of Television, D. Gerbarg, Springer
2. Applications and Usability of interactive TV, Maris Jos Abisolo, Springer
3. IPTV Delivery network, Suliman Mohamed Fati, Saiful Azad, Al-Sakib Khan Pathan, Wiley Publications
4. Television Engineering & Video Systems, R. G. Gupta, McGraw Hill Publication
5. Quantum dot based light emitting diodes, Morteza Sasani Ghamsari, Google book

Online References:

Sr. No.	Website Name
1.	https://archive.nptel.ac.in/courses/117/104/117104020/?utm_source
2.	https://archive.nptel.ac.in/courses/117/105/117105081/?utm_source
3.	https://archive.nptel.ac.in/courses/117/105/117105080/?utm_source

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Pract	Tut	Total
ETC552	Data Compression and Cryptography	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC552	Data Compression and Cryptography	20	20	40	60	2.5	-	--	100

Rationale:

The subject Data Compression and Cryptography integrates two critical areas of information technology—efficient data representation and secure data transmission. It begins with fundamental techniques for data, image, audio, and video compression, including popular standards like JPEG, MPEG, and AAC, equipping students with the ability to reduce storage and transmission costs without significant loss of quality. The second half focuses on cryptographic principles essential for securing digital communications, covering both symmetric and asymmetric key systems, including AES, RSA, and hash functions. Through the study of number theory, encryption algorithms, and system-level security mechanisms such as firewalls and biometric authentication, students gain a holistic understanding of data confidentiality, integrity, and access control. This subject lays a vital foundation for careers in cybersecurity, multimedia systems, and secure software development, preparing students for real-world challenges in the digital and connected age.

Course Objectives:

1 Gain a fundamental understanding of data compression methods for text, images, video and audio.

2. Understand the concepts of cryptography and different algorithms to provide system security.

Course Outcomes:

After successful completion of the course student will be able to:

1. Apply various compression techniques for text and understand image compression and its standards.
2. Select suitable compression techniques for specified lossless and lossy audio and video applications.
3. Compare between symmetric and asymmetric cryptography and also describe different symmetric cryptographic techniques and standards.
4. Apply number theory concepts to solve the cryptographic problems.
5. Analyze different public key cryptography algorithms and also describe methods that provide the goals for integrity, confidentiality and authentication.
6. Describe system security facilities designed to protect a computer system from security threats and also appreciate ethical issues related to system security.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to Data Compression**	1.1 Data compression, modelling and coding, Lossless and Lossy Compression, Arithmetic Coding – Decoding, Dictionary Based Compression, Sliding Window Compression:LZ-77, LZ-78, LZW. 1.2 Image Compression DCT, JPEG, JPEG – LS, Differential Lossless Compression, DPCM, JPEG – 2000 Standards	06	CO1
II	**Video and Audio Compression**	2.1 Video compression: Motion compensation, temporal and spatial prediction, MPEG-4, H.264 encoder and decoder.	06	CO2

		2.2 Sound, Digital Audio, μ-Law and A-Law Companding, MPEG –4 Audio Layer, Advanced Audio Coding (AAC) standard. **Self-learning Topics:** Introduction to H.265 and AV1		
III	**Data Security**	3.1 Security Goals, Cryptographic Attacks and Techniques 3.2 Symmetric Key: Substitution Cipher, Transposition Cipher , Stream and Block Cipher 3.3 DES, double DES and triple DES, AES	10	CO3
IV	**Number Theory**	4.1 Prime Numbers, Fermat's and Euler's Theorem. 4.2 Chinese Remainder Theorem.	04	CO4
V	**Asymmetric Key Cryptography**	5.1 Principles of Public Key CryptoSystem, RSA, Key Management, Deffie-Hellman Key Exchange. 5.2 Message Integrity, Message Authentication and Hash Functions, SHA, HMAC, Digital Signature Standards. **Self-learning Topics:** Cryptographic application in Blockchain (conceptual)	9	CO5
VI	**System Security**	6.1 Intrusion Detection System, Secure Electronic Transactions. 6.2 Firewall Design, Digital Immune systems, Biometric Authentication, Ethical Hacking. **Self-learning Topics:** More applications	4	CO6

Text Books:

1. Khalid Sayood , 3rd Edition, |Introduction to Data Compression|, Morgan Kauffman

2. Mark Nelson, Jean-Loup Gailly,‖The Data Compression Book‖, 2nd edition, BPB Publications

3. William Stallings ,|Cryptography and Network Security Principles and Practices 5th Edition‖, Pearson Education.

4. Behrouz A. Forouzan, |Cryptography and Network Security‖, Tata McGraw-Hill.

References:

1. David Salomon, |Data Compression: The Complete Reference‖, Springer.

2. Matt Bishop, |Computer Security Art and Science‖, Addison-Wesley.

3. Bernard Menesez,| Network Security and Cryptography| Delmar Cengage Learning, 7th Edition.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC553	IT Infra & Security	**3**	**-**	**-**	**3**	**-**	**-**	**3**

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC553	IT Infra & Security	20	20	40	60	2.5	--	--	100

Rationale:

This course equips students with essential knowledge of IT infrastructure, security principles, and ethical practices. It fosters the ability to design, manage, and secure modern IT systems, addressing challenges like sustainability, digital safety, and societal impact, in alignment with NEP 2020 and UNSDGs.

Course Objectives:

1. To analyze IT infrastructure from a sustainability and innovation perspective.
2. To evaluate infrastructure security with respect to ethical practices and digital rights.
3. To investigate and mitigate software and web vulnerabilities considering societal impact.
4. To demonstrate proactive security practices in wireless and web systems for digital safety.
5. To design inclusive, secure IT systems contributing to responsible digital ecosystems.

Course Outcomes:

1. Describe the components and management strategies of IT Infrastructure.
2. Explain the ethical and legal implications of information security.
3. Identify and Classify software vulnerabilities and their impact.

4. Evaluate security mechanisms in OS and databases for data integrity.
5. Develop secure wireless protocols using current technologies.
6. Implement secure coding practices to defend against web-based attacks.

Prerequisite: 1) Principles of Communication

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Principles of Communication		
I	**Overview of Networks and IT Infrastructure**	**Modern Networking Foundations**: ● Overview of **OSI** and **TCP/IP** Models ● Introduction to **IP Addressing Schemes** (IPv4 & IPv6) ● Introduction to Networking Components: **Routers, Switches, Firewalls, Access Points** **Sustainable IT Infrastructure Design:** ● Concept of **Information Technology (IT)** in organizational contexts ● **Design issues** of IT organizations: agility, scalability, energy efficiency ● **Information System Design Process** (with case studies on smart cities or green data centers) **IT Infrastructure Management:** Principles and practices of IT Infrastructure Management Challenges: e-waste, cost, scalability, compliance, disaster recovery Identifying Customer Requirements for sustainable and secure IT operations Introduction to Security Controls and Safeguards Drafting an IT Security Plan (based on real-world templates or NIST framework) **Self-learning Topics:** Research IPv6 address types (unicast, multicast, anycast).	09	CO1

II	**Introduction to Information Security**	• Types of Cyber-attacks: phishing, DoS, ransomware • System Vulnerabilities and common threat vectors • Defense strategies and multi-layered security approaches • Authentication Methods: Passwords, Tokens, Biometrics • Access Control Policies and Models: DAC, MAC, RBAC, BIBA, Bell-LaPadula • Authentication Services: RADIUS, TACACS, TACACS+ **Self-learning Topics:** • Study defense strategies, such as employee education, email filtering, and multi-factor authentication.	06	CO2
III	**Software Vulnerabilities**	• Buffer overflow, Format String, Cross-Site Scripting (XSS), SQL Injection • Malware types: Viruses, Worms, Trojans, Logic Bombs, Bots, Rootkits • Ethical implications of exploitation and disclosure **Self-learning Topics:**Research best practices for securing databases and web applications against SQL injection attacks.	04	CO3
IV	**Operating System and Database Security**	• Introduction to **OS Security Concepts** and **Security Architecture** • **System Security Planning**: risk assessment, patch management • **Application Security**: secure software deployment, sandboxing • **Platform-specific Security**: o Linux/Unix: file permissions, SELinux, security modules o Windows: User Account Control (UAC), group policies, NTFS permissions • **Security Maintenance**: auditing, log analysis, intrusion detection **Database Security:** • **Security Requirements** for databases: confidentiality, integrity, availability • Ensuring **Reliability and Data Integrity** • Protection of **Sensitive Data**: encryption, masking, anonymization • **Inference Attacks**: risks in statistical databases and how to mitigate	08	CO4

		● **Multilevel Security Models** for databases (MLS): Bell-LaPadula, Biba, role-based policies **Self-learning Topics:**Learn about Linux/Unix file permissions (read, write, execute) and access control (ownership, groups).		
V	**Wireless Security**	Need for Wireless Network Security Attacks: MITM, Jamming, Eavesdropping Security Protocols: WEP, WPA, WPA2, WPA3 VPNs: PPTP, L2TP, IPSec Mobile IP and secure mobile communications **Self-learning Topics:**Research common wireless network attacks and mitigation strategies.	05	CO5
VI	**Web Security**	● Web Protocols, Data Formats, Web Browser threats ● Authenticated sessions: Cookies, Session Hijacking, Privacy concerns ● Code Origin Policies, XSS, CSRF, JavaScript Hijacking ● Introduction to OWASP Top 10 **Self-learning Topics:**Study how XSS attacks occur and how to prevent them	07	CO6

Text Books:

1. Gupta, “IT Infrastructure & Its Management”, Tata McGraw-Hill Education
2. William Stallings, “Computer Security: Principles and Practice”, 6th Edition, Pearson
3. Dieter Gollmann, “Computer Security”, 3rd Edition, Wiley Publications
4. Behrouz A. Forouzan, “Data Communications and Networking”, 5th Edition, McGraw-Hill
5. P. Nicopolitidis et al., “Wireless Networks”, Wiley Publications

Reference Books:

1. Charles P. Pfleeger & Shari Lawrence Pfleeger, “Security in Computing”, 5th Edition, Pearson
2. Tim Boyle, “CCNA Security Study Guide”, Wiley Publications
3. Matt Bishop, “Introduction to Computer Security”, Pearson
4. OWASP Foundation, “OWASP Top 10” (Latest Edition)
5. National Institute of Standards and Technology (NIST) Publications, U.S. Department of Commerce
6. Sunit Belapure & Nina Godbole, “Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives”, Wiley

Online References:

Sr. No.	Website Name
1.	https://www.coursera.org
2.	https://www.udemy.com
3.	https://www.cybrary.it

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Pract.	Tut.	Total
ETC554	Data Structure & Algorithm	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC554	Data Structure & Algorithm	20	20	40	60	2.5	--	--	100

Rationale:

Data Structures and Algorithms form the backbone of efficient software development. This subject is essential for understanding how data can be organized, stored, and manipulated effectively to solve computational problems. Mastery of algorithms enables students to write optimized code that performs well in terms of speed and memory. By learning this subject, students develop critical problem-solving skills, logical thinking, and a foundation necessary for advanced topics in computer science, such as databases, operating systems, and artificial intelligence.

Course Objectives:

1. To Introduce the fundamental knowledge & need of Data Structures.
2. To abstract the concept of Algorithm and these concepts are useful in problem solving.
3. To Implement fundamental knowledge and applications of Stack, Queue, Linked List, Trees, Graphs etc.
4. To Understand the working of different Sorting, Searching & Hashing techniques
5. To understanding about writing algorithms and step by step approach in solving problems with the help of fundamental data structures.

Course Outcomes:

1. Compare functions using asymptotic analysis and describe the relative merits of worst-, average-, and best-case analysis.
2. Apply various operations on Stack and Queue.
3. Ability to demonstrate the operation of Linked list.
4. Ability to demonstrate and apply Trees & Graph data structures.
5. Become familiar with various Sorting and Searching Algorithms and their performance characteristics.
6. Describe the hash function and concepts of collision and its resolution methods

Prerequisite:

1) Skill Lab: Python Programming

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Control Structures, Arrays, Recursion, Pointers, Structures, Memory Allocation Techniques, Self-referential structures.		
I	Introduction to Data Structure & Algorithm	1. Introduction to Data Structures, Concept of ADT, Types of Data Structures- Linear and Nonlinear, Operations on Data Structures. 2. Algorithm: Performance characteristics of algorithm, Importance of Algorithm Analysis, Complexity of an Algorithm, Introduction to Asymptotic Analysis and Notations.	05	CO1
II	Stack & Queue	1.Introduction to Stack, ADT of Stack, Operations on Stack, Array Implementation of Stack 2.Applications of Stack- Infix to Postfix Expression Conversion, Infix Expression to Prefix Expression Conversion, Postfix Expression Evaluation	08	CO2

		3.Introduction to Queue, ADT of Queue, Operations on Queue, Array Implementation of Queue, Types of Queue-Circular Queue, Priority Queue, Introduction to Double Ended Queue 4.Applications of various types of Queue Self-Learning Topic: Well form-ness of Parenthesis using Stack		
III	Linked List	1.Introduction, Linked List v/s Array, Representation of Linked List, Types of Linked List - Singly Linked List, Doubly Linked List 2.Operations on Singly Linked List and Doubly Linked List 3.Singly Linked List Application-Polynomial Representation and Addition, Doubly Linked List Application Self-Learning Topic: Stack and Queue using Singly Linked List	07	CO3
IV	Trees & Graph	1.Introduction, Tree Terminologies, Binary Tree, Binary Tree Representation, Types of Binary Tree, Binary Tree Traversals, Binary Search Tree, Operations on Binary Search Tree, 2. Applications of Binary Tree-Expression Tree, Huffman Encoding. 3. Graph: Introduction, Graph Terminology, Memory Representation of Graph, Operations Performed on Graph. 4. Graph Traversal, Breadth First Search, Depth First Search, Applications of the Graph, Shortest Path, Minimum Spanning Tree.	09	CO4
V	Searching & Sorting	Searching: Sequential Search, Index Sequential Search, Binary Search Sorting: Bubble Sort, Quick Sort, Merge Sort Self-Learning Topic: Selection Sort, Insertion Sort	06	CO5
VI	Hashing	Hashing-Concept, Hash Functions, Common hashing functions Collision resolution Techniques	04	CO6

Text Books:

1. Jean Paul Tremblay, P. G. Sorenson, “Introduction to Data Structure and its Applications”, McGraw-Hill Higher Education
2. “Fundamentals of Computer Algorithms” Ellis Horowitz, Sartaj Sahani and Sanguthevar Rajasekaran, Second Edition, Universities Press (India) Pvt. Ltd.
3. “Learning with Python” Allen Downey, Jeffrey Elkner, Chris Meyers, Dreamtech Press

References:

1. Jean Paul Tremblay, Paul G. Sorenson; An introduction to data structures with applications; Tata McGrawHill; 1984
2. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, “Algorithms”, Tata McGrawHill Edition.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC555	Sensor Technology	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC555	Sensor Technology	20	20	40	60	2.5	--	--	100

Rationale:

This course aims to provide a comprehensive understanding of the Internet of Things (IoT) and Industry 4.0, focusing on their architecture, communication protocols, data management, and industrial applications. It equips students with the knowledge and tools required to design, develop, and analyze IoT-enabled smart systems across various domains, preparing them for the digital transformation in industry. The inclusion of emerging technologies like AI, AR/VR, and Industry 5.0 ensures learners are aligned with future-ready innovations.

Course Objectives:

1. To introduce the foundational concepts of the Internet of Things (IoT), including architecture, design principles, and communication standards.
2. To explore the network protocols and communication technologies used for IoT connectivity and interoperability.
3. To impart knowledge on data acquisition, management, analytics, and real-time processing using modern big data tools.

4. To understand the evolution, architecture, and components of Industry 4.0 and Industrial IoT (IIoT).
5. To examine practical applications of IIoT in various sectors such as healthcare, manufacturing, and power systems.
6. To introduce advanced Industry 4.0 technologies like cyber-physical systems, AI, AR/VR, and explore the transition to Industry 5.0.

Course Outcomes:

1. Explain the fundamental concepts, components, and design aspects of IoT and differentiate it from M2M systems.
2. Analyze and apply suitable communication protocols and network technologies for efficient IoT deployment.
3. Use big data and real-time analytics tools (e.g., Hadoop, Spark, Storm) to manage and process IoT data.
4. Illustrate the key elements and architecture of Industry 4.0 and Industrial IoT systems.
5. Evaluate the role of IoT in industrial domains and identify challenges in designing secure and efficient IIoT solutions.
6. Describe the emerging concepts of Industry 5.0, including human-machine collaboration and cognitive computing through case studies.

Prerequisite:

1) Computer networks
2) Python or C/C++
3) Microcontrollers/microprocessors

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to IoT**	**Introduction -** Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Sources of IoT,	4	CO1

		IoT and M2M - IoT/M2M System layers and Design standardization, Difference between IoT and M2M **Defining Specifications About -** Purpose & requirements, process, domain model, information model, service, IoT level, Functional view, Operational view, Device and Component Integration, Application Development, Case Study		
II	**Network & Communication aspects**	**Design Principles & Web Connectivity -** Web Communication Protocols for connected devices, Web connectivity using Gateway, SOAP, REST, HTTP, RESTful and Web Sockets (Publish —Subscribe), MQTT, AMQP, CoAP Protocols **Internet Connectivity: -** Internet connectivity, Internet based communication, IP addressing in IoT, Media Access Control, Application Layer Protocols. LPWAN Fundamentals: LORA, NBIoT, CAT LTE Ml, SIGFOX, Case Study	8	CO2
III	**Data Management and Analytics for IoT**	Introduction, Apache Hadoop, Using Hadoop MapReduce for Batch Data Analysis, Apache Oozie, Apache Spark, ApacheStorm, Using Apache Storm for Real-time Data Analysis Analysis, Structural Health Monitoring Case Study, Tools for IoT:- Chef, Chef Case Studies, Puppet, Puppet Case Study- Multi-tier Deployment, NETCONF-YANG Case Studies, IoT Code Generator	8	CO3

IV	**Introduction to Industry 4.0**	Industry 4.0: Managing the Digital Transformation, Conceptual framework for Industry 4.0, Industrial IoT (IIoT) - Introduction, Business Model and Reference Architecture, Industrial IoT- Layers, Sensing, Processing, Communication. Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality	8	CO4
V	**Introduction to Industrial IoT (IIoT)**	Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security, Facility Management. Artificial Intelligence, Cybersecurity in Industry 4.0, Internet of Things for Industry 4.0 Design, Challenges and Solutions	6	CO5
VI	**Industry 4.0 Technologies and Applications**	Internet of Things and New Value Proposition.: Examples for IoTs Value Creation in Different Industries., IoTs Value Creation Barriers: Standards, Security and Provacy Concerns Introduction to Industry 5.0, Human Machine Interaction, cognitive computing with human intelligence, Case study on AI based solutions	5	CO6

Text books:

1. ArshdeepBahga and Vijay Madisetti, “Internet of Things: A Hands-on Approach, Universities Press.
2. Raj Kamal, “ Internet of Things: Architecture and Design Principles”, McGraw Hill Education ,First edition

3. Radha Shankarmani, M Vijayalakshmi, "Big Data Analytics", Wiley Publications,

4. Andrew Minteer ,"Analytics for the Internet of Things(IoT)",Kindle Edition

5. Giacomo Veneri , Antonio Capasso," Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0", Packt

Suggested reference material (research papers):

1. https://www.mdpi.com/2071-1050/11/16/4371/pdf- Industry .0—A Human-Centric Solution – MDPI (open access)
2. https://www.researchgate.net/profile/Mary-Doyle Kent/publication/336819748_Industry_50_Is_the_Manufacturing_Industry_on_the_Cusp_of_a_New_Revolution/links/5e84b810a6fdcca789e5ff75/Industry-50-Is-the- Manufacturing-Industry-on-the-Cusp-of-a-New-Revolution.pdf - Industry 5.0: Is the Manufacturing Industry on the Cusp of a New Revolution?

Reference books

1. Alp Ustundag Emre Cevikcan," Industry 4.0: Managing The Digital Transformation",
Springer Series in Advanced Manufacturing
2. G. R. Kanagachidambaresan, R. Anand, E. Balasubramanian, V. Mahima, Internet of Things for Industry 4.0. EAI/Springer Innovations in Communication and Computing
3. The Internet of Things (Connecting objects to the web) by Hakima Chaouchi (Wiley Publications).
4. The Internet of Things (MIT Press) by Samuel Greengard
5. Adrian McEwen, Hakim Cassimally, : Designing the Internet of Things", Paperback,First Edition

Suggested MOOCs:

1. https://onlinecourses.nptel.ac.in/noc20_cs69 - Introduction to Industry 4.0 and Industrial Internet of Things, By Prof. Sudip Misra, IIT Kharagpur
2. https://www.edx.org/course/industry-40-how-to-revolutionize-your-business - Industry 4.0: How to Revolutionize your Business
3. https://onlinecourses.nptel.ac.in/noc21_cs17 - Introduction to internet of things, by Prof. Sudip Misra , IIT Kharagpur
4. https://onlinecourses.nptel.ac.in/noc21_cs08 - Embedded Systems Design
5. By Prof. Anupam Basu, IIT Kharagpur

Online References:

Sr. No.	Website Name
1.	Node Red - https://nodered.org/
2.	M2MLabs Mainspring - http://www.m2mlabs.com/
3.	Tensor Flow - https://www.tensorflow.org/
4.	Things Speak - https://thingspeak.com/

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETL506	Digital Communication Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT 1	IAT 2	Total				
ETL506	Digital communication Lab	--	--	--	--	25	25	50

Lab Objectives:

1. Analyze the fundamental principles of information theory and source coding for efficient data transmission.
2. Design and evaluate various error control codes to ensure reliable communication in diverse environments.
3. Design, implement, and evaluate different channel coding techniques
4. Develop and optimize baseband systems for robust digital signal transmission.
5. Evaluate the performance of optimum baseband detection in the presence of white noise
6. Compare different digital modulation and demodulation techniques

Lab Outcomes:

After the successful completion of the course student will be able to

1. Apply the concepts of information theory in source coding.
2. Compare different error control systems and apply various error detection codes.
3. Analyze different error correction codes.
4. Compare various baseband transmission methods for digital signals.
5. Evaluate the performance of optimum baseband detection in the presence of white noise.
6. Evaluate the performances of different digital modulation techniques

List of Experiments

Sr No	List of Experiments	Hrs
01	Generation (and detection) of Binary ASK	2
02	Generation (and detection) of Binary FSK	2
03	Generation (and detection) of Binary PSK	2
04	Generation (and detection) of QPSK	2
05	Linear block code generation and error detection	2
06	Generation (and detection) of M-ary PSK	2
07	Generation (and detection) of M-ary FSK	2
08	Generation (and detection) of MSK	2
09	Cyclic code generation and error detection	2
10	Convolutional code generation	2
11	Line Codes generation and performance comparison	2
12	Spectrum of line codes (NRZ unipolar and polar)	2
13	Impulse responses of ideal (Nyquist filter) and practical (Raised cosine filter) solution for zero ISI	2
14	Matched filter impulse response for a given input	2
15	Compare various source coding schemes	2
16	Design and implement different error detection codes	2

17	Design and implement different error correction codes	2
18	Compare various line coding techniques	2

Sr No	List of Assignments / Tutorials	Hrs
01	Assignment based on Source coding algorithms	2
02	Assignment based on Channel coding Techniques	2
03	Assignment based ISI and optimum receiver	2
04	Assignment based on different modulation techniques	2

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practicals' based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETL507	Discrete-Time Signal Processing Laboratory	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT1	IAT 2	Total				
ETL507	Discrete-Time Signal Processing Laboratory	--	--	--	--	25	25	50

Lab Objectives:

The objective of the course is-

1. To introduce students to digital signal generation and representation in time and frequency domains.
2. To provide practice in frequency domain analysis using DFT, IDFT, and Z-Transform techniques.
3. To develop skills for performing convolution operations using circular and block convolution methods.
4. To guide students in designing and simulating FIR and IIR digital filters using standard design techniques.
5. To build awareness of implementation-level challenges such as finite word-length effects and quantization.

6. To encourage innovation through a mini-project that applies DSP concepts to real-world problems (e.g., health, audio, communication)

Lab Outcomes:

Students will be able to

1. Apply software tools to generate and visualize basic signals in the time and frequency domain.
2. Analyze discrete-time systems using Z-transform, DFT, and IDFT.
3. Perform convolution operations and compare the output of circular and block convolution methods.
4. Design and simulate FIR and IIR digital filters using standard design procedures.
5. Evaluate filter realizations and study the effect of coefficient quantization using simulation tools.
6. Create a DSP-based application in a team setting, demonstrating problem-solving and communication skills.

List of Experiments:

Sr. No.	List of the Experiment	Hrs
1	To generate basic signals.	2
2	To study Z-Transform using a pole-zero plot.	2
3	To study DFT-IDFT.	2
4	To study Circular convolution.	2
5	To perform block convolution using overlap - add & Overlap Save method	2
6	To study design of Low pass Butterworth Filter using Bilinear Transform Method.	2
7	To study design of FIR filters using the Rectangular Window function.	2
8	To realise an IIR filter in cascade and parallel form.	2
9	To perform coefficient quantization error using truncation and rounding.	2

10	Application oriented one course-project (maximum batch of four students)	2

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practicals' based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETL508	Digital VLSI Laboratory	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT 1	IAT 2	Total				
ETL508	Digital VLSI Laboratory	--	--	--	--	25	25	50

Lab Objectives:

1. To become familiar with open source circuit simulation tools like Ngspice, Magic etc.
2. To perform various type of analysis of combinational and sequential CMOS circuits
3. To evaluate performance of given combinational and sequential CMOS circuits
4. To design, implement and verify combinational and sequential CMOS circuits using open source VLSI design tools.

Lab Outcomes:

1. Write spice code for given combinational and sequential CMOS circuits.
2. Perform various analysis like operating point, dc, transient etc of given CMSO

circuits.

3. Evaluate performance of given CMOS circuits.
4. Draw layout of given CMOS circuit and also able extract various parasitic using open source layout tool like Magic.
5. Design, simulate, and verify CMOS circuit for given specifications.

List of Experiments.

Sr No	List of Experiments	Hrs
01	Constant Voltage and Constant field MOSFET scaling	2
02	Layout of MOSFET and extraction of parasitic capacitances	2
03	Voltage transfer characteristics of CMOS inverter and calculation of Noise Margin and static power	2
04	Transient Analysis of CMOS inverter and calculation of tpHL, tpLH, tr, tf, average power	2
05	Design of CMOS inverter for given specifications	2
06	Layout of CMOS inverter and comparison of pre layout and post layout performance.	2
07	Voltage transfer characteristics of 2 input NAND/NOR gate and calculation of noise margins and validation using equivalent inverter approach.	2
08	Transient Analysis of 2 input NAND/NOR CMOS gate and calculation of tpHL, tpLH, tr, tf, average power and validation using equivalent inverter approach.	2
09	Layout of 2 input CMOS NAND/NOR gate and comparison of pre layout and post layout performance.	2
10	Static and transient analysis of Complex CMOS gate.	2
11	Layout of complex CMOS gate using euler path.	2

12	Implementation of various combinational and sequential circuits using different design styles.	2
13	Design and implementation of NAND based and NOR based ROM array.	2
14	Performance analysis of 6T-SRAM Cell	2
15	Design of 6T SRAM cell robust read and write operation.	2
16	Performance analysis of 1T and 3T DRAM Cell	2
17	RTL design of Soda dispenser machine	2
18	RTL design of FIR Filter	2

Online Resources:

Sr. No.	Website Name
1.	http://www.vlsi-iitg.vlabs.ac.in

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practicals' based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Pract.	Tut.	Total
ETL509	Professional Communication & Ethics-II	-		-	-	2	-	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETL509	Business Communication & Ethics	-	-	-	-	-	25	25	50

Rationale:

This curriculum is designed to build up a professional and ethical approach, effective oral and written communication with enhanced soft skills. Through practical sessions, it augments student's interactive competence and confidence to respond appropriately and creatively to the implied challenges of the global Industrial and Corporate requirements. It further inculcates the social responsibility of engineers as technical citizens.

Course Objectives:

1. To discern and develop an effective style of writing important technical/business documents.
2. To investigate possible resources and plan a successful job campaign.

3. To understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement.
4. To develop creative and impactful presentation skills.
5. To analyze personal traits, interests, values, aptitudes and skills.
6. To understand the importance of integrity and develop a personal code of ethics.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
1	Advanced Technical Writing :Project/Problem Based Learning (Pbl)	1.1 Purpose and Classification of reports: Classification on the basis of: · Subject Matter (Technology, Accounting, Finance, Marketing, etc.) · Time Interval (Periodic, One-time, Special) · Function (Informational, Analytical, etc.) · Physical Factors (Memorandum, Letter, Short & Long) 1.2. Parts of a Long Formal Report: · Prefatory Parts (Front Matter) · Report Proper (Main Body) · Appended Parts (Back Matter) 1.3. Language and Style of Reports · Tense, Person & Voice of Reports · Numbering Style of Chapters, Sections, Figures, Tables and Equations	08	CO1

		· Referencing Styles in APA & MLA Format · Proofreading through Plagiarism Checkers 1.4. Definition, Purpose & Types of Proposals · Solicited (in conformance with RFP) & Unsolicited Proposals · Types (Short and Long proposals) 1.5. Parts of a Proposal · Elements · Scope and Limitations · Conclusion 1.6. Technical Paper Writing · Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References) · Language and Formatting · Referencing in IEEE Format		
2	Employment Skills	2.1. Cover Letter & Resume · Parts and Content of a Cover Letter · Difference between Bio-data, Resume & CV · Essential Parts of a Resume · Types of Resume (Chronological, Functional & Combination) 2.2 Statement of Purpose	06	CO2

		· Importance of SOP · Tips for Writing an Effective SOP 2.3 Verbal Aptitude Test · Modelled on CAT, GRE, GMAT exams 2.4. Group Discussions · Purpose of a GD · Parameters of Evaluating a GD · Types of GDs (Normal, Case-based & Role Plays) · GD Etiquettes 2.5. Personal Interviews · Planning and Preparation · Types of Questions · Types of Interviews (Structured, Stress, Behavioural, Problem Solving & Case-based) · Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual		
3	Business Meetings	BUSINESS MEETINGS 3.1 Conducting Business Meetings · Types of Meetings · Roles and Responsibilities of Chairperson, Secretary and Members · Meeting Etiquette 3.2. Documentation · Notice · Agenda · Minutes	02	CO3
4	Technical/ Business Presentations	4.1 Effective Presentation Strategies · Defining Purpose · Analyzing Audience, Location and Event	02	CO4

		· Gathering, Selecting &Arranging Material · Structuring a Presentation · Making Effective Slides · Types of Presentations Aids · Closing a Presentation · Platform skills 4.2 Group Presentations · Sharing Responsibility in a Team · Building the contents and visuals together · Transition Phases		
5	Interpersonal Skills	INTERPERSONAL SKILLS 5.1 Interpersonal Skills · Emotional Intelligence · Leadership & Motivation · Conflict Management & Negotiation · Time Management · Assertiveness · Decision Making 5.2 Start-up Skills · Financial Literacy · Risk Assessment · Data Analysis (e.g. Consumer Behavior, Market Trends, etc.)	08	CO5
6	Corporate Ethics	CORPORATE ETHICS 6.1 Intellectual Property Rights · Copyrights · Trademarks · Patents · Industrial Designs · Geographical Indications · Integrated Circuits · Trade Secrets (Undisclosed Information) 6.2 Case Studies · Cases related to Business/ Corporate Ethics	02	CO6

Textbooks and Reference:

1. Arms, V. M. (2005). Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition. Boston, MA: McGraw-Hill.

2. Bovée, C. L., &Thill, J. V. (2021). Business communication today. Upper Saddle River, NJ: Pearson.

3. Butterfield, J. (2017). Verbal communication: Soft skills for a digital workplace. Boston, MA: Cengage Learning.

4. Masters, L. A., Wallace, H. R., & Harwood, L. (2011).Personal development for life and work. Mason: South-Western Cengage Learning.

5. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). Organizational behaviour. Harlow, England: Pearson.

6. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press

7. Archana Ram (2018) Place Mentor, Tests of Aptitude For Placement Readiness. Oxford University Press

8. Sanjay Kumar & PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Online References:

Sr. No.	Website Name
1.	http://www.digimat.in/nptel/courses/video/110105079/L01.html
2.	https://onlinecourses.nptel.ac.in/noc21_mg46/preview
3.	https://archive.nptel.ac.in/courses/110/105/110105052/

Assessment:

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETL510	Mini Project 2A: Embedded System Project	--	04$	--	--	02	--	02

$ Indicates work load of a learner (Not Faculty) for Mini Project 2A.
Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT 1	IAT 2	Total				
ETL510	Mini Project 2A: Embedded System Project	--	--	--	--	25	25	50

Lab Objectives:

1. To Describe the fundamental architecture and characteristics of embedded systems.
2. To Investigate the scope of embedded systems in solving real-world challenges.
3. To Select appropriate microcontrollers and interface components for specific applications.
4. To Apply wireless communication standards for data transmission in embedded systems.
5. To Develop real-time and IoT-enabled embedded applications.
6. To Evaluate the social and environmental implications of their solutions.

Lab Outcomes:

1. Define a project problem aligned with SDG indicators and justify its relevance.
2. Design embedded system prototypes to address sustainability or social impact.
3. Demonstrate practical skills in configuring sensors, actuators, and embedded programming.
4. Collaborate effectively in teams to develop, document, and present their work.
5. Analyze technological, ethical, and ecological considerations in their solutions.
6. Validate performance using standard test procedures and make improvements.

A. Guideline to maintain quality of mini project are as follows:

1. To achieve proper selection of Mini Projects.Students should do a survey of different microcontroller boards from given microcontroller series tools and identify which is most suitable for their selected topic. They should consult with their Guide/Mentors / Internal committee to finalize it.
2. Students shall submit implementation plans in the form of Smart Report/Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
3. A log book to be prepared by each group, wherein the group can record weekly work progress. Guide/ supervisor will verify it and will put notes/comments.
4. Guide/supervisor guidance is very much important during mini project activities; however, focus shall be on self-learning.
5. The solution to be verified with standard tools and procedures and report to be compiled in standard format of University of Mumbai.
6. Suggested steps for mini project selection and implementation
   i. Mini project should be completely microcontroller based

   ii. Follow these steps

a) Take specification, using these specifications design project.
b) Select proper microcontroller board considering features and requirements of project.
c) Program it using Embedded C and perform verification of each module (sensors/communication protocol)

d) Test Functional Simulation and verify it using simulation tool.

e) Make hardware connection on GPP of peripherals with microcontroller board and execute the program.

f) Troubleshoot if not get expected result.

B. Project Topic selection and approval:-

1. The group may be of **maximum FOUR (04)** students.

2. Topic selection and approval by **2 Expert** faculty from department at the start of semester

3. **Log Book** to be prepared for each group to record the work progress in terms of milestones per week by students. Weekly comment, remarks to be put by guiding faculty. Both students and faculty will put signature in it per week. The log book can be managed **online** with proper authentication method using google sheets/forms or open source project management software.

C. Project Report Format:

1. Report should not exceed **30 pages**. Simply staple it to discourage use of plastic.

2. Report must contain block diagram, circuit diagram, screenshot of outputs and datasheets of microcontrollers and peripherals (Include **only required** information pages).

3. The recommended report writing format is in **LaTeX. (https://youtu.be/YLm3sXlKpHQ)**

Term Work:

1. Term Work evaluation and marking scheme:

. The review/ progress monitoring committee shall be constituted by Head of Departments of each institute.

a. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.

b. At end of semester the above 2 expert faculty who have approved the topic will internally **evaluate the performance**.

c. Students have to give presentation and demonstration on the Embedded Systems Mini Project- 2-A at end of semester before submission to above experts.

d. In the evaluation each individual student should be assessed for his/her contribution, understanding and knowledge gained about the task completed. Based upon it the marks will be awarded to student.

e. **Distribution of 25 Marks scheme** is as follows:

.Marks awarded by guide/supervisor based on log book and output : 10

i.Marks awarded by review committee : 10

ii.Quality of Project report : 05

2. Guidelines for Assessment of Mini Project Practical/Oral Examination:

a. Report should be prepared as per the guidelines issued by the University of Mumbai.

b. Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and **External Examiners preferably from industry or research organisations** having experience of more than five years approved by the head of Institution.

Students shall be motivated to present their MiniProject work done

1. Participate in Project Competition
2. Publish paper in Conferences/Journals.

Prerequisite:

1. Microcontrollers
2. Linear Integrated Circuits
3. Mini Project 1B: Arduino & Raspberry Pi based Projects

DETAILED SYLLABUS:

Mod No.	Unit No.	Detailed Content	Hrs
1		**Introduction**	**8**
	1.1	Definition of Embedded System, Embedded Systems Vs General Computing Systems, Classification, Major Application Areas. Characteristics and quality attributes (Design Metric) of embedded system.	
	1.2	Identification of Project Title	
2		**Controller boards and Programming – Embedded C**	**8**
	2.1	ARM LPC 21XX (2148), STM32 boards and Texas MSP 430 lunchbox/ Tiva C board and **PIC/PSoc***	
	2.2	Comparison of C and embedded C, Data Types, Variable, Storage Classes, Bit operation , Arrays, Strings, Structure and unions, Classifier	

	2.3	**Exercise:** Identify the suitable board required for the particular application with respect to design metrics. (**Hint:** check clock frequency (speed) , memory (program and data), no. of ports for peripherals, timers/counters and serial communication requirement for project)	
	2.4	**Suggested Way to Identify :** https://predictabledesigns.com/how-to-select the-microcontroller-for-your-new-product/	
3		**Interfacing Sensors and peripherals using Embedded C**	**10**
	3.1	Sensors and Signal Conditioning Circuits amplifiers /attenuators /filters /comparators/ADC and DAC) , Interfacing with GLCD/TFT display , Relays and Drivers for interfacing Motors (DC and stepper)	
	3.2	Interfacing with BLDC motors and drivers, USB/HDMI camera interfacing	
	3.3	**Exercise :** Understand the Interfacing requirement like drivers, signal condition circuits for sensors, etc. for the selected application	
	3.4	**Study Material : For LCD interfacing with MSP430 LaunchPad** https://microcontrollerslab.com/lcd-interfacing-msp430-launchpad/#:~:text=LCD%20interfacing%20with%20MSP430%20microcontroller,Now%20I%20will&text=It%20requires%205%20volts%20dc,and%20seco nd%20pin%20is%20vcc.	
4		**Communication with programming in Embedded C**	**10**
	4.1	Serial communication, CAN bus, I2C, MOD bus, SPI	
	4.2	Interfacing with Wi-Fi, Bluetooth ,ZigBee, LoRa, RFID and putting data on IoT	
	4.3	Interfacing with GSM module , GPS module, SD card	
	4.4	**Exercise:** Understand Communication requirement for selected application and test it	

	4.5	**Study Material :** Serial Communication Interface: **STM32:**https://controllerstech.com/serial-transmission-in stm32/#:~:text=Serial%20Transmission%20in%20Stm32&text =UART%20is %20widely%20used%20for,amongst%20which%20communic ation%20is%20 done. **LPC2148:** https://www.electronicwings.com/arm7/lpc2148-uart0 **MSP430:** https://www.ti.com/lit/ml/slap117/slap117.pdf	
5		**Real Time Operating Systems[RTOS]**	**08**
	5.1	Operating system basics , Types of OS , Tasks, process, Threads	
	5.2	Multiprocessing and ,Multitasking , Task scheduling	
	5.3	RTLinux/ Free RTOS and Mbed OS , Implementation with RTOS	
6		**Cloud/Web server**	**08**
	6.1	Implementation on web server ,	
	6.2	Thingspeak, AWS cloud platform for IoT based programming and modelling	
	6.3	**Exercise : perform ESP8266 interface with microcontroller**	
	6.4	**Study Material :** **STM32:** https://circuitdigest.com/microcontroller-projects/interfacing_esp8266-with-stm32f103c8-stm32-to-create-a-webserver **LPC2148:** https://circuitdigest.com/microcontroller-projects/iot-based-ARM7- LPC2148-webserver-to-control-an-led **MSP430:** https://circuitdigest.com/microcontroller-projects/sending-email using-msp430-and-esp8266	

NOTE:

* **Advanced Microcontroller:** Like PSoc and PIC may be used as per the student's intellectual ability and strength.

** **Module 5 and 6 (RTOS and Cloud/Web Server):** Can be included by Guide /supervisor /Mentor depending upon need and scope of the project for selected topic and its application.

Textbooks:

1. Shibu K.V," Introduction to Embedded Systems", Mc Graw Hill, 2nd edition.
2. Frank Vahid, and Tony Givargis, "Embedded System Design: A unified Hardware/Software Introduction", Wiley Publication.
3. Raj Kamal," Embedded Systems Architecture, Programming and design",Tata MCgraw-Hill Publication.
4. Dr. K.V.K.K. Prasad, "Embedded Real Time Systems: Concepts, Design & Programming",Dreamtech Publication.
5. Iyer, Gupta," Embedded real systems Programming", TMH
6. David Simon, "Embedded systems software primer',Pearson
7.Andrew Sloss, Dominic Symes and Chris Wright, "ARM_System_Developers_Guide Elsevier and Morgan Kaufmann Publishers. 8. Michel J Pont "Embedded C" Pearson

Suggested Software tools:

1. Tinkercad : https://www.tinkercad.com/
2. Proteus software
3. KEIL for ARM LPC 2148
4. **STM32Cube software**
5. MSP Flasher - Command Line Programmer
6. msp430 code composer studio

NPTEL Courses:

1. Introduction to Embedded System Design (using MSP430)
https://onlinecourses.nptel.ac.in/noc20_ee98/preview
2. Embedded System Design with ARM
https://onlinecourses.nptel.ac.in/noc20_cs15/preview
3. Embedded systems
https://nptel.ac.in/courses/108/102/108102045/
4. Master Microcontroller and Embedded Driver Development (MCU1) STM32
https://www.udemy.com/course/mastering-microcontroller-with-peripheral-driver development/?gclid=CjwKCAjw07qDBhBxEiwA6pPbHslLI EqmAv7E17ysZETb e0XMb8Nai4NBqpUAvni5v 3fLKsfNBoC8LQQAvD_BwE&matchtype=b&utm_ campaign=LongTail_la.EN_cc.INDIA&utm_content=deal4584&utm_medium=ud emyads&utm_source=adwords&utm_term=_._ag_82876601447_._ad_511749008 36_._kw_%2Bembedded+%2Bsystems+%2Bcourse_._de_c_._dm_ _._pl__._ti_kwd-671751469914_._li_1007785_._pd__._
5. Texas Instruments (TI) Trainings
https://e2e.ti.com/support/archive/universityprogram/educators/w/wiki/2103/traini ng-support

6. Texas Instruments

Sr. No.	**Website Name**
1.	. https://circuitdigest.com
2.	www. Github.com
3.	https://www.electronicshub.org
4.	https://www.hackster.io/

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Pract.	Tut	Total
ETC 601	Electromagnetics and Antenna	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract /Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC 601	Electromagnetics and Antenna	20	20	40	60	2.5	--	--	100

Rationale:

The *course* provides a comprehensive understanding of the fundamental principles governing electric and magnetic fields, electromagnetic wave propagation, and antenna theory—key pillars of modern wireless communication systems. Beginning with static fields and Maxwell's equations, the course builds up to dynamic wave behavior in various media and power transmission using the Poynting theorem. It then transitions into antenna fundamentals, exploring radiation mechanisms, antenna parameters, and design concepts for various types of antennas including dipoles, arrays, horns, reflectors, and microstrip antennas. Emphasis on both theoretical derivations and practical applications prepares students to design, analyze, and apply antenna systems in real-world scenarios like satellite communication, radar, and mobile networks. This subject forms a crucial foundation for careers in RF engineering, telecommunications, and embedded wireless technologies.

Course Objectives:

1 Understand the basic concepts of electrostatics and magnetostatics

2 Apply Maxwell's equations in differential and integral forms to analyze time-varying Electromagnetic fields and wave propagation.

3 Explain the fundamental radiation mechanisms and basic antenna concepts

4 Analyze the performance of linear and planar antenna arrays

5 Explore different types of antennas such as Yagi, Horn, Reflector, and Microstrip antennas

6 Understand the different modes of electromagnetic wave propagation

Course Outcomes:

1. Students will be able to describe electromagnetics field including static and dynamic in terms of Maxwell's equations.
2. Students will be able to apply Maxwell's equation to solve various electromagnetic phenomena such as electromagnetic wave propagation in different mediums, power in EM waves.
3. Students will derive the field equations for the basic radiating elements and describe basic antenna parameters like radiation pattern, directivity, gain etc
4. Students will be able to implement different types of the antenna structures such as Antenna arrays
5. Design and analyse special types of antenna like Microstrip antenna and reflector antenna etc. and understand their applications.
6. Identify radio wave propagation types in wireless communication channels and understand important phenomena occurring within them.

Prerequisite:

1. Vector Calculus
2. Fundamental concepts of electricity and magnetism

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Vector Algebra, Co-ordinate systems	2	
I	**Introduction to Static fields**	1.1 Charge, Coulomb's law, Charge configurations, Electric field intensity, Electric flux density, Gauss's law and applications, Current density, and Continuity equation 1.2 Scalar Electric Potential, Potential gradient, Laplace's and Poison's equations	6	CO1

		1.3 Biot Savart Law, Ampere Circuit law, Gauss's law for magnetic field, Vector magnetic potential		
II	**Electromagnetic Field and Maxwell's Equations**	2.1 Faraday's Law, Displacement current density, Maxwell's equation for time varying field, Boundary conditions. 2.2 EM wave propagation through lossy, perfect dielectric and conducting medium. 2.3 Power in EM Wave: Poynting theorem and Poynting vector	8	CO2
III	**Basics of Antennas**	3.1 Basic concepts: Radiation mechanism, Near field and far field radiation, retarded potential 3.2 Antenna Parameters: Isotropic antenna, Radiation pattern, radiation intensity, Beamwidth, directivity, Gain, beam efficiency, bandwidth, polarization, Input impedance, Antenna efficiency, Radiation resistance, Loss resistance, aperture concept, FRII's transmission formula 3.3 Wire Elements: Infinitesimal dipole, Wire dipole, Monopole antennas: radiation field derivations and related parameters, Introduction to loop antenna	8	CO3
IV	**Antenna Arrays**	4.1 Linear arrays of two isotropic point sources, linear arrays of N elements, Principle of pattern multiplication 4.2 Introduction to Planar and circular arrays Introduction to array synthesis using Binomial array	6	CO4
V	**Types of antennas**	5.1 Yagi antenna, Broadband antenna like Helical and Log Periodic antenna Horn Antennas**:** E-Plane Sectoral Horn, H-Plane Sectoral Horn, Pyramidal Horn and Conical Horn 5.2 Reflector Antennas: Plane Reflectors, Corner Reflectors and Parabolic Reflector 5.3 Patch Antenna: Microstrip antenna, Feeding Techniques, Introduction to design	6	CO5

		of Microstrip antenna (Rectangular and circular patch) **Self-learning Topics: Different Antennas used for wireless communication**		
VI	**Electromagnetic Wave Propagation**	6.1 Ground Wave Propagation, Sky Wave Propagation and Space Wave Propagation	3	CO6

Text Books:

1. Electromagnetic Waves and Radiating Systems- Jordan and Balmain, PHI, 2nd edition

2. Principles of Electromagnetics Engineering- Matthew N. O.Sadiku , S.V.Kulkarni, Oxford university press, 6th edition

3. Antenna Theory: Analysis and Design, Costantine A. Balanis, John Wiley Publication, 4th edition

4. Antenna and wave Propagation, John D Kraus, A S Khan, McGraw Hill, 4th edition

5. Antenna Theory and Design. Stutzman, Theile, John Wiley and Sons, 3rd edition

References:

1. Engineering Electromagnetics, William H Hayt and John A Buck, Tata McGraw-Hill Publishing Company Limited, 7th edition

2. Antennas and Radio Wave Propagation, R. E. Collin, McGraw Hill, International Student Edition

Subject Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ETC602	Computer Communication Networks	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam.				
		IAT 1	IAT 2	Total					
ETC602	Computer Communication Networks	20	20	40	60	2.5	-	-	100

Rationale :

This course provides essential knowledge of computer communication networks, covering architectures, protocols, and security with an emphasis on sustainable and smart digital infrastructure. It equips students with practical skills through simulations and hands-on labs, fostering industry readiness for roles such as Network Engineer and System Administrator. The curriculum aligns with NEP 2020 and UNSDGs, promoting environmentally conscious and socially responsible network design.

Course pre-requisite:

1. Principles of communication engineering
2. Digital communication

Course Objectives:

1. To design and analyze modern computer communication networks for smart and sustainable environments.
2. To explore the TCP/IP architecture and compare it with OSI models using real-world applications.
3. To apply knowledge of networking principles in solving problems aligned with digital infrastructure and sustainability.

4. To simulate, evaluate, and secure network protocols with environmental and societal awareness.

Course Outcomes:

After successful completion of the course student will be able to:

1. Analyze various network architectures, protocols, and addressing schemes.
2. Compare broadband technologies and evaluate their environmental impact.
3. Apply flow control and error control methods in data link protocols.
4. Design routing strategies and implement efficient routing protocols.
5. Distinguish between transport layer services and construct error-free connections.
6. Demonstrate application layer protocols for real-world services like e-Governance

Detailed Syllabus:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Principles of communication engineering,Digital communication	01	
1	**Introduction to Network Architectures, Protocol Layers, and Service models**	• Applications of Computer Networks. • Types of Networks: LAN, MAN, WAN. • Network Topologies: Bus, Star, Ring, Mesh. • Protocols and Standards; OSI vs TCP/IP. • Network Hardware Devices.	06	CO1
2	**Physical Layer**	• Guided Media: Twisted pair, coaxial, optical fiber. • Unguided Media: Radio, microwave, infrared. • Transmission Impairments: Attenuation, noise, distortion. • Broadband Access Technologies: Cable modem, DSL, HFC.	04	CO2
3	**Data Link Layer**	• Data Link Services: Framing, Flow control, Error control. • ARQ Methods: Stop-and-Wait, Go-Back-N, Selective Repeat. • HDLC: Modes, frame types, bit stuffing. • MAC Protocols: ALOHA, CSMA, CSMA/CD.	07	CO3
4	**Network Layer**	• Circuit and Packet Switching. • IPv4: Packet format, addressing. • Routing Algorithms: RIP, OSPF, BGP, EIGRP.	12	CO4

		• Address Management: Subnetting, VLSM, NAT. • Support Protocols: ICMP, ARP, RARP. • IPv6 and Transition Techniques. • QoS Metrics and Mechanisms.		
5	**Transport Layer**	• TCP: Services, segments, handshake. • UDP: Features and datagram. • Checksum Computation. • Flow, Error, Congestion Control.	06	CO5
6	**Application Layer**	• HTTP, FTP, DNS, SMTP, TELNET, SSH, DHCP. • Application scenarios: e-learning, governance, IoT.	04	CO6

Textbooks

- Data Communications and Networking – Behrouz A. Forouzan, Fifth Edition, TMH, 2013.
- Computer Networks – Andrew S. Tanenbaum, 5th Edition, Pearson Education, 2013.
- Computer Networking: A Top-Down Approach – Kurose and Ross, 5th Edition, Addison Wesley, 2010.

Additional Reference Books

- Data and Computer Communications – William Stallings, 10th Edition, Pearson.
- An Engineering Approach to Computer Networks – S. Keshav, 2nd Edition, Pearson.
- Understanding Communications and Networks – W. A. Shay, 3rd Edition, Cengage Learning.
- Green Networking and Communications – Constantine Polychronopoulos, CRC Press.
- UNESCO ICT Competency Framework for Teachers (ICT-CFT).

Online References:

Sr. No.	**Website Name**
1.	https://onlinecourses.nptel.ac.in/
2.	https://www.netacad.com/courses/packet-tracer
3.	https://developer.mozilla.org/en-US/docs/Web/HTTP

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut	Total
ETC603	Image Processing and Machine Vision	03	--	--	03	--	-	03

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC603	Image Processing and Machine Vision	20	20	40	60	2.5	--	--	100

Rationale:

Image Processing and Machine Vision play a vital role in enabling machines to interpret and analyze visual information. This subject provides students with foundational knowledge and practical skills in image enhancement, feature extraction, and object recognition. It is widely applied in areas like medical imaging, automation, robotics, surveillance, and smart systems. Learning these techniques prepares students to develop intelligent systems that can see and make decisions, addressing real-world challenges across industries.

Course Objectives:

1. To teach the fundamentals and mathematical models in digital image processing and Machine Vision
2. To teach quality enhancement of image through filtering operations
3. To teach the students image morphology and restoration techniques
4. To expose the students to segmentation techniques in image processing and Machine Vision
5. To teach the techniques of extracting image attributes like regions and shapes

6. To learn classification and recognition algorithms for machine vision

Course Outcomes:

After successful completion of the course student will be able to:

1. Demonstrate a comprehensive understanding of the core concepts and mathematical foundations of digital image processing and machine vision.
2. Utilize spatial and frequency domain techniques to effectively enhance image quality, addressing practical imperfections in visual data.
3. Execute image morphology operations and apply restoration algorithms to improve image structure .
4. Implement and compare various image segmentation algorithms, critically evaluating their performance for specific applications.
5. Construct effective representations of image boundaries and shapes, preparing visual data for pattern analysis and recognition.
6. Develop and evaluate object classification and recognition models, demonstrating their utility in automated visual tasks.

Prerequisite:

1. Signals and Systems
2. Discrete Time Signal Processing
3. Python Programming Skill Lab

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Digital Image Fundamentals And Point Processing**	Introduction –Steps in Digital Image Processing, concept of spatial and intensity resolution, Relationships between pixels. **Point Processing :** Image Negative, Log Transform, Power Law transform,Bit plane slicing, Contrast stretching , Histogram equalization and Histogram Specification.	4	CO1
II	**Image Enhancement**	**Spatial Domain filtering** : The Mechanics of Spatial Filtering,	8	CO2

		Smoothing Spatial Filters-Linear Filters-Averaging filter, Order-Statistic Filters- Median filter, Application of Median filtering for Noise removal **Sharpening Spatial Filters**- The Laplacian, Unsharp Masking and High Boost Filtering, Using First-Order Derivatives —The Gradient- Sobel,Prewitt and Roberts		
III	**Image Morphology And Restoration**	**Morphology:** Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transformation, Boundary extraction , Hole filling, Thinning and thickening **Restoration** : A Model of the Image Degradation/Restoration Process, Noise models, Removal periodic noise, Principle of Inverse filtering	6	CO3
IV	**Image Segmentation**	**Point, Line, and Edge Detection:** Detection of Isolated Points, Line detection, edge models, Canny's edge detection algorithm , Edge linking : Local processing and boundary detection using regional processing **Thresholding** : Foundation, Role of illumination and reflectance, Basic global thresholding **Region Based segmentation**: Region Growing, Region Splitting and merging	8	CO4
V	**Introduction To Machine Vision And**	Principle of machine vision , real world applications, chain code, simple geometric border representation, Fourier Transform of	5	CO5

	Descriptors	boundaries, Boundary description using segment sequences Introduction to Texture, co-occurrence matrix		
VI	**Machine Vision Algorithms**	Knowledge representation, Classification Principles, Classifier setting, Classifier Learning, Confusion Matrix,K-means clustering algorithm, Introduction, bayes decision theory continuous case, two category classification, Bayesian classifier ,Support vector machine, Application of ML in prediction	8	CO6

Text Books:

1. Milan Sonka ,Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis, and Machine Vision” Cengage Engineering, 3rd Edition, 2013
2. Gonzales and Woods, “Digital Image Processing”, Pearson Education, India, Third Edition,
3. R. O. Duda and P. E. hart, Pattern classification and scene analysis, Wiley Interscience publication
4. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006

References:

1. Anil K.Jain, “Fundamentals of Image Processing”, Prentice Hall of India, First Edition, 1989.
2. W Pratt, “Digital Image Processing”, Wiley Publication, 3rd Edition, 2002
3. Forsyth and Ponce, Computer vision: A modern approach, PHI
4. Frank Y Shish ,Image Processing and Pattern Recognition: Fundamentals and Techniques, Wiley Wiley-IEEE Press, 2010

Online References:

Sr. No.	Website Name
1.	https://archive.nptel.ac.in/courses/117/105/117105135/
2.	https://archive.nptel.ac.in/courses/117/105/117105135/
3.	https://onlinecourses.nptel.ac.in/noc23_cs18/preview

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract	Tut.	Total
ETC604	Artificial Neural Networks and Fuzzy Logic	03	--	--	03	--	--	03

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC604	Artificial Neural Networks and Fuzzy Logic	20	20	40	60	2.5	--	--	100

Rationale:

This subject equips students with foundational and advanced concepts in neural networks and fuzzy systems, enabling them to model, analyse, and design intelligent systems used in modern AI applications like classification, control, and automation.

Course Objectives:

1. To introduce the fundamentals of artificial neurons and neural network architectures.
2. To analyze supervised and unsupervised learning methods and training algorithms.
3. To explore various neural network models including Perceptron, MLP, and CNN.
4. To understand optimization techniques like backpropagation and gradient descent.
5. To study fuzzy logic concepts, membership functions, and inference mechanisms.
6. To evaluate applications of ANN and fuzzy systems in real-world scenarios.

Course Outcomes:

On successful completion of the course students will be able to

1. Explain the architecture and function of various neural network models, Implement supervised learning techniques such as Perceptron and MLP with back propagation.
2. Apply unsupervised learning models like Kohonen networks and K-means clustering.
3. Develop simple CNN architectures for basic image classification tasks.
4. Describe fuzzy sets, fuzzification, defuzzification, and fuzzy inference systems.
5. Integrate neural network and fuzzy logic approaches for intelligent system applications.

Prerequisite:

1. Basic Linear Algebra: Matrices, vectors, dot product, linear transformations.
2. Probability and Statistics: For understanding learning algorithms and model evaluation.
3. Basic Programming Knowledge: Python or MATLAB for neural network implementation.
4. Signals and Systems: Understanding of system modeling and transformations.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to Neural Networks and their Basic Concepts**	Biological neuron and Artificial neuron, McCulloch-Pitts Model, Activation Function, various types of Activation Functions and types of Neural Network Architectures, Prerequisites for Training of Neural Networks. Linearly Separable and Linearly Non-Separable Systems with examples, Concepts of Supervised Learning, Unsupervised Learning, and Reinforcement Learning. Brief survey of applications of Neural Networks.	4	CO1
II	**Supervised Learning Neural Networks**	Perceptron - Single Layer Perceptron, Multilayer Perceptron and their Architecture. Error Functions: Mean Square Error and Sum Squared Error. Gradient Descent, Generalized delta rule, Error back propagation, Stopping Criterions for Training.	8	CO2
III	**Unsupervised Learning Neural Networks**	Competitive Learning Network – Kohonen Self-Organizing Networks – Architecture, Training Algorithm, Discrete Hopfield Network- Hopfield Matrix, Testing Algorithm, K-Means Clustering Algorithm.	8	CO3

IV	**Algorithms of Neural Networks**	Basic concept of Machine Learning, Support Vector Machine (SVM) - Introduction and SVM based Binary Classifier, LMS Algorithm.	8	CO4
V	**Convolution Neural Network (CNN)**	Basic concept of Deep Learning, Convolution Operation, Overview of CNN Architecture, Input layer, Convolution layers, Pooling layers, Padding, Strided Convolutions, Rectified Linear Unit (ReLU), One Layer of a Convolutional Network, Fully Connected Layers, Complex Image Classification using CNN.	6	CO5
VI	**Introduction to Fuzzy Inference System**	Introduction to Fuzzy Logic, Fuzzy Rules, Fuzzy Properties - Operations, Membership Functions, Fuzzification - Membership Value Assignments using Intuition Method, Defuzzification Methods -- Mean of Maxima and Centroid (Centre of Area) Methods, Fuzzy Inference System with reference to Mamdani Model, Brief Review of Applications of Fuzzy Logic to Speed Control of DC Motor and Washing Machine	5	CO6

Text books:

1. S. N. Sivanandam and S. N. Deepa, Introduction to Soft Computing, Wiley India Publications, 3rd Edition.
2. Simon Haykin, Neural Networks and Learning Machines, Pearson Prentice Hall, 3rd Edition
3. S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic, and Genetic Algorithms, PHI Learning Pvt. Ltd, 2003.
4. Practical Convolutional Neural Networks by Mohit Sewak, Md. Rezaul Karim, Pradeep Pujari, Packt Publishing, 2018.
5. Timothy J. Ross, Fuzzy Logic with Engineering Applications, Wiley India Publications, 3rd Edition.

Reference books:

1. Hagan, Demuth, and Beale, Neural Network Design, Thomson Learning, 2nd Edition.
2. Simon Haykin, Neural Network- A Comprehensive Foundation, Pearson Education, 2nd Edition.
3. Christopher M. Bishop, Neural Networks for Pattern Recognition, Oxford University Press, 2005.
4. William W. Hsieh, Machine Learning Methods in the Environmental Sciences: Neural Network and Kernels, Cambridge University Press, 2009.

5. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016
6. S. N. Sivanandam, S. Sumathi, and S. N. Deepa, Introduction to Neural Network using Matlab, Tata McGraw-Hill Publications, 2006.
7. Mehrotra Kishan, Mohan C. K. Ranka Sanjay, Elements of Artificial Neural Networks, Penram International Publishing Pvt. Ltd, 2nd Edition.
8. J. M. Zurada, Introduction to Artificial Neural Systems, Jaico Publishers, 2006.
9. Bart Kosko, Neural Networks and Fuzzy Systems, Pearson Education, 2007.

Suggested reference material (research papers):

1. https://www.sciencedirect.com/science/article/abs/pii/S1568494620302155
2. https://arxiv.org/vc/arxiv/papers/1807/1807.03215v2.pdf

Suggested MOOCs:

1. https://onlinecourses.nptel.ac.in/noc21_ge07/preview
2. https://archive.nptel.ac.in/courses/106/105/106105173/

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Pract	Tut.	Total
ETC651	Mixed Signal VLSI	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract /Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC651	Mixed Signal VLSI	20	20	40	60	2.5	--	--	100

Rationale:

This course introduces students to the design and analysis of mixed signal VLSI circuits, including analog CMOS building blocks and data converters. It prepares them for advanced IC design tasks essential in modern electronics and communication systems.

Course Objectives:

1. To understand the design and function of current mirrors and biasing circuits in CMOS technology.
2. Analyze and simulate single-stage and differential MOS amplifiers using SPICE tools.
3. To study various noise sources in MOS circuits and their impact on performance.
4. To design CMOS operational amplifiers, including two-stage OTA with compensation techniques.
5. To explore data converter principles and mixed-signal system requirements.
6. To introduce layout considerations and architecture of DACs and ADCs for real-world implementation.

Course Outcomes:

On successful completion of the course students will be able to

1. Apply integrated circuit biasing techniques and analyze current mirrors in VLSI circuits.
2. Design and simulate single-stage and differential MOS amplifiers using industry tools.
3. Identify and model noise sources in analog and mixed-signal circuits.
4. Develop CMOS operational amplifiers and apply compensation methods effectively.
5. Differentiate and design various ADC and DAC architectures based on application needs.
6. Implement mixed-signal design layout practices including floor planning and power-ground strategies.

Prerequisite:

1. Analog Electronics: Knowledge of MOSFET operation, biasing, and small-signal models.
2. Digital VLSI Design: Basics of CMOS logic design, layout, and simulation.
3. Electronic Circuits: Familiarity with amplifier configurations and frequency response.

SPICE Simulation Tools: Basic experience in circuit simulation using tools like LTspice or Cadence.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Integrated Circuit Biasing Techniques**	Active resistance, current source, current sink, simple current mirror, cascode current mirror Current and voltage references, Band gap reference generator	4	CO1
II	**Single Stage MOS Amplifiers**	Common-source stage (with resistive load, diode connected load, current-source load, triode load, source degeneration), source follower, common-gate stage, cascode stage, folded cascade stage, simulation of CMOS amplifiers using SPICE Single-ended operation, differential operation, basic differential pair, large-signal and small-signal behavior, common-mode response, differential pair with MOS loads, simulation of differential amplifiers using SPICE	8	CO2

III	**Noise in MOS Circuits**	Noise spectrum, correlated and uncorrelated noise sources, thermal noise, flicker noise, shot noise Representation of noise in circuits, noise in single stage CS, CD and CG amplifier Noise in differential pairs, noise bandwidth	8	CO3
IV	**CMOS Operational Amplifier**	Design of Current Mirror Load Differential Amplifier Design of two stage Operational Transconductance Amplifier, OpAmp Compensation techniques	8	CO4
V	**Data Converter Fundamentals**	Analog versus digital discrete time signals, converting analog signals to data signals, sample and hold characteristics Mixed signal Layout issues, Floor planning, power supply and Ground issues, other interconnect Considerations	6	CO5
VI	**Data Converter Architectures**	DAC architectures, digital input code, charge scaling DACs, Cyclic DAC, pipeline DAC ADC architectures, flash, pipeline ADC, integrating ADC, and successive approximation ADC	5	CO6

Text books:

1. B. Razavi, “Design of Analog CMOS Integrated Circuits”, first edition, McGraw Hill,2001.
2. P.E.Allen and D R Holberg, “CMOS Analog Circuit Design”, second edition, Oxford University Press, 2002.
3. R. Jacob Baker, “CMOS Circuit Design, Layout and Simulation”, Wiley, 2nd Edition, 2013.

Reference books:

1. Adel S. Sedra, Kenneth C. Smith, A.N. Chandorkar, “Microelectronics Circuits Theory and Applications”, Fifth Edition, Oxford University Press.

2. Gray, Meyer, Lewis and Hurst "Analysis and design of Analog Integrated Circuits", 4th Edition Willey International, 2002
3.Tony Chan Carusone, David Johns, Kenneth Martin, " Analog Circuit Design", Second Edition, Wiely

Suggested reference material (research papers):

1. https://vlsijournal.com/index.php/vlsi/article/view/139
2. https://www.iosrjournals.org/iosr-jvlsi/papers/vol6-issue3/Version-2/H0603024953%20.pdf

Suggested MOOCs:

1. https://onlinecourses.nptel.ac.in/noc23_ee137/preview
2. https://www.bing.com/videos/riverview/relatedvideo?q=nptel+course+on+mixed+signal+vlsi&mid=257FF477EE2A99BBEF00257FF477EE2A99BBEF00&mcid=835FA65F5938489E9F55976B1917FCA8&FORM=VIRE

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC652	Computer Organisation and Architecture	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC652	Computer Organisation and Architecture	20	20	40	60	2.5	--	--	100

Rationale:

This course lays the groundwork for understanding the structural and operational principles of computer systems, covering both fundamental and advanced architecture. It focuses on the functional design of processors, memory systems, control units, and data processing techniques, while also introducing emerging paradigms like multicore and parallel architectures.

Course Objectives:

1. To explain the difference between computer organization and architecture and evaluate system performance using Amdahl's and Little's laws.
2. To describe the functional units of a computer system and the role of interconnection structures like buses.
3. To analyze algorithms for arithmetic operations such as multiplication and division, and interpret IEEE 754 floating-point standards.
4. To explore the design of memory systems including cache, virtual memory, and various storage technologies.

5. To understand the working of control units and distinguish between hardwired and microprogrammed control strategies.
6. To introduce advanced computer architecture concepts including multicore systems, NUMA, clusters, and Flynn's taxonomy of parallelism.

Course Outcomes:

After successful completion of the course student will be able to:

1. Explain and interpret architectural elements, performance laws, and benchmarking techniques.
2. Describe system components and interconnections, including bus architecture.
3. Apply and implement number representation and arithmetic algorithms like Booth's and IEEE 754.
4. Analyze memory hierarchy and evaluate cache and virtual memory mechanisms.
5. Design and simulate control units using hardwired and microprogrammed techniques.
6. Compare and evaluate multiprocessor and parallel architectures, including multicore and NUMA

Prerequisite:

1. Digital System Design
2. Microcontrollers

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Computer Organization, Architecture and Performance**	Organization and Architecture,Structure and Function,Designing for Performance,Multicore, MICs, and GPGPUs,Two Laws that Provide Insight: Amdahl's Law and Little's Law,Basic Measures of Computer Performance,Calculating the Mean,Benchmarks and SPEC	08	CO1
II	**Computer System**	Computer Components,Computer Function,Interconnection Structures,Bus Interconnection	06	CO2
III	**Data Representation**	Unsigned & Signed multiplication-Add & Shift Method, Booth's	05	CO3

	and Arithmetic Algorithms	algorithm.Unsigned & Signed division, Restoring and non-restoring division. Integer and floating point representation, IEEE 754 standard for floating point (Single & double precision) number representation.		
IV	**Memory System Organization**	Classification and design parameters, Memory Hierarchy ,Internal Memory: RAM, SRAM and DRAM,Cache Memory: Characteristics of Memory Systems, Cache Memory Principles, Elements of Cache, Cache Coherence. Design problems based on mapping techniques,Virtual Memory, External Memory : Magnetic Discs, Solid State Drive, Optical Memory, Flash Memories, RAID Levels	07	CO4
V	**Control Unit Design**	Micro- Operations: The Fetch Cycle, The Indirect Cycle, The Interrupt Cycle, The Execute cycle, The Instruction Cycle,Control of the Processor: Functional Requirements, Control Signals, Internal Processor Organization,Hardwired Control Unit,Microinstructions Microprogrammed Control Unit, Advantages & disadvantages	08	CO5
VI	**Fundamentals of Advanced Computer Architecture**	Parallel Architecture: Classification of Parallel Systems,Flynn's Taxonomy, Array Processors, Clusters, and NUMA Computers,Multiprocessor Systems : Structure & Interconnection Networks, Multi-Core Computers: Introduction, Organization and	05	CO6

		Performance.		

Text Books:

1. William Stallings “Computer Organization and Architecture Designing for Performance” Tenth Edition, Pearson Education.
2. C. Hamacher, Z. Vranesic and S. Zaky, "Computer Organization", McGrawHill,
3. Andrew S. Tanenbaum “Structured Computer Organization”, Pearson, Sixth Edition

Reference books:

1. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design”

2. Morris Mano. “Computer System Architecture” Pearson Publication, 3rd Edition, 2007

3. J .P. Hayes, "Computer Architecture and Organization", McGraw-Hill, 1998

4. B. Govindarajulu, “Computer Architecture and Organization: Design Principles and Applications”, Second Edition, Tata McGraw-Hill.

Online References:

Sr. No.	**Website Name**
1.	https://onlinecourses.nptel.ac.in/noc21_cs61/preview

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut	Total
ETC653	Digital Forensics	**3**	**-**	**-**	**3**	**-**	**-**	**3**

Course Code	Course Name	Theory					Term work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC653	Digital Forensics	20	20	40	60	2.5	--	--	100

Rationale :

This course prepares students to investigate cybercrimes through systematic digital forensics techniques. It develops skills in evidence handling, forensic analysis of systems and networks, and understanding of cyber laws, fostering readiness for careers in cybersecurity and digital justice.

Course Objectives:

1.To examine the landscape of cybercrime and its evolving challenges.
2.To analyze the stages and techniques in digital forensics and incident response.
3.To apply procedures for identification, preservation, analysis, and reporting of digital evidence.
4.To use forensic tools and methods to investigate system and network intrusions.
5.To interpret legal frameworks and ethical considerations in cyber law and digital justice.

Course Outcomes:

1. Describe types of cybercrimes, cybercriminal motives, and digital threats
2. Outline the digital forensics lifecycle and incident response methodology
3. Perform evidence collection, preservation, and forensic imaging
4. Utilize forensic tools (e.g., FTK, Autopsy) for system and disk investigation
5. Analyze network traffic and identify indicators of compromise.
6. Interpret relevant cyber laws and evaluate levels of digital culpability.

Prerequisite:

1. Computer Communication Networks

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Computer Communication Networks	01	
I	**Introduction to Cybercrime and Hacking**	● Types and categories of cybercrime (violent, non-violent). ● Life cycle and types of hackers ● Social engineering and threat vectors	08	CO1
II	**Foundations of Digital Forensics**	● Objectives, types, and process of digital forensics ● CSIRT and incident response phases	07	CO2
III	**Digital Evidence and Forensic Duplication**	● Evidence handling, admissibility, preservation ● Forensic duplication techniques: FTK, Autopsy, Disk imaging	07	CO3
IV	**System Investigation**	● Live/volatile data collection (Windows, Unix) ● Investigating email, browser, and apps ● Recovery tools: dd, dcfldd, scalpel **Self-learning Topics:**RAM vs hard disk storage	08	CO4
V	**Network Forensics**	● IDS types, network attacks, evidence acquisition ● Router log investigation, traffic analysis	05	CO5
VI	**Cyber Laws and Legal Frameworks**	● Levels of law: local to international ● Key Acts: ITA, CFAA, DMCA, CAN-Spam ● Culpability models: intent, recklessness, negligence	04	CO6

Textbooks:

- Kevin Mandia & Chris Prosise, Incident Response and Computer Forensics, Tata McGraw-Hill
- Nilakshi Jain & Kalbande, Digital Forensics, Wiley
- Nina Godbole & Sunit Belapure, Cyber Security, Wiley
- Marjie T. Britz, Computer Forensics and Cyber Crime, Pearson (3rd Ed.)

Reference Books:

- Bill Nelson et al., Guide to Computer Forensics and Investigations, Cengage Learning
- Debra Shinder & Michael Cross, Scene of the Cybercrime, Syngress
- NIST SP 800-86: Guide to Integrating Forensic Techniques into Incident Response

Online References:

Sr. No.	Website Name
1.	https://www.sans.org/
2.	https://swayam.gov.in/
3.	https://digital-forensics.sans.org/community/downloads

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Pract	Tut.	Total
ETC654	Database Management System	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC654	Database Management System	20	20	40	60	2.5	--	--	100

Rationale:

A Database Management System (DBMS) is fundamental for storing, organizing, and managing large volumes of data efficiently and securely. This subject equips students with the knowledge and skills to design relational databases, write SQL queries, and understand data models, normalization, and transaction management. Proficiency in DBMS is essential for developing reliable, scalable, and data-driven applications across various domains in computer science and industry.

Course Objectives:

1 Learn and practice data modeling using the entity-relationship and developing database designs.

2 Understand the use of Structured Query Language (SQL) and learn SQL syntax.

3 Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access

4 Understand the concept of database security and privacy

Course Outcomes:

1. Describe the fundamentals of database systems.
2. Describe different data models
3. Design ER diagram, relational schemas, and discuss design issues in database.
4. Understand the basics model of relational Algebra, calculus, apply concepts of normalization to relational database design.
5. Implement views, triggers and querying the database using SQL.
6. Understand transaction management, concurrency control, database security and privacy

Prerequisite:

1. C Programming
2. Skill Lab :- C++ and Java Programming
3. Skill Lab :- Python Programming

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	Introduction to Databases	Introduction to databases, History of database system, Benefits of Database system over traditional file system, relational databases, Three tier database architecture, Data independence	02	CO1
II	Data Models	The importance of data models, Introduction to various data models (hierarchical, Network, Relational, Entity relationship and object model), Basic building blocks, Business rules, Degrees of data abstraction	03	CO2
III	Database Design, ER-Diagram and Unified Modeling Language	1.Database design and ER Model: overview, ER-Model and its Constraints, ER-Diagrams, ERD Issues, weak entity sets 2.Codd‘s rules, Relational Schemas, Introduction to UML Relational database model: Logical view of data, keys, integrity rules.	08	CO3

		Relational Database design: features of good relational database design, atomic domain		
IV	Relational Algebra and Calculus	Relational algebra: Introduction, Selection and projection, set operations, renaming, Joins, Division, syntax, semantics. Operators, grouping and ungrouping, relational comparison. Calculus: Tuple relational calculus, Domain relational Calculus, calculus vs algebra, computational capabilities. Normalization methods : 1NF, 2NF, 3NF, BCNF, 4NF, 5NF	09	CO4
V	Constraints, Views and SQL	What is constraints, types of constrains, Integrity constraints, SQL: data definition, aggregate function, Null Values, nested sub queries, Joined relations. Triggers. Views: Introduction to views, data independence, security, updates on views, comparison between tables and views ** SQL Tools : MySQL, ORACLE 10G, POSTGRESQL	10	CO5
VI	Transaction management and Concurrency control	Transaction management: ACID properties, serializability and concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping methods, optimistic methods, database recovery management. Database Security and privacy : Issues, Access Control based on grant and revoke privileges	07	CO6

**** Teacher can select any one SQL Tool for implementation of SQL query**

Text Books:

1. A Silberschatz, H Korth, S Sudarshan, “Database System and Concepts‖”, Fifth Edition McGraw-Hill

2. Rob, Coronel, “Database Systems”, Seventh Edition, Cengage Learning.

3. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database System‖", Seventh Edition, Person.

4. G. K. Gupta, "Database Management Systems‖", McGraw – Hill.

References:

1. Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", Thomson Learning, 5th Edition.

2. P.S. Deshpande, "SQL and PL/SQL for Oracle 11g, Black Book", Dreamtech Press

3. Mark L. Gillenson, Paulraj Ponniah, "Introduction to Database Management", Wiley

4. Raghu Ramkrishnan and Johannes Gehrke, "Database Management Systems", TMH

5. Debabrata Sahoo "Database Management Systems‖ Tata McGraw Hill, Schaum's

Outline

Online References:

Sr. No.	Website Name
1.	https://www.w3schools.in/dbms/
2.	https://www.tutorialspoint.com/dbms/index.htm
3.	https://www.studytonight.com/dbms/

Self-Learning: Suggested Case Studies (Any such cases can be selected by Teacher)

1. Library Management System
2. Hospital Management System
3. Pharmacy Management System
4. Human Resource Database Management System in Java
5. Students Database Management System
6. Employee Management System
7. Inventory Control Management database

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC655	IoT and Industry 4.0	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC655	IoT and Industry 4.0	20	20	40	80	2.5	--	--	100

Rationale:

The course “IoT and Industry 4.0” equips students with the knowledge to understand and implement smart, connected systems in industrial environments. It emphasizes the integration of IoT technologies with digital manufacturing processes. Students learn about communication protocols, data analytics, and real-time monitoring essential for Industry 4.0. The course fosters innovation by exposing learners to emerging technologies like AI, AR/VR, and cyber-physical systems. This prepares graduates to contribute effectively to the digital transformation of industries.

Course Objectives:

1. To offer introduction to Internet of Things and industry 4.0 standard
2. To understand the design features of Internet of Things (IOT)
3. To understand concepts of data management and data analytics in IoT
4. To understand the concept and framework of industry 4.0 standard
5. To understand the application of IoT and Industry 4.0 Standard

Course Outcomes:

On successful completion of the course students will be able to

1. Discuss case studies and use cases of IoT design
2. Illustrate various protocols of web connectivity
3. Understand and use tools for data management and analytics in IoT
4. Explain various frameworks for industry 4.0 standards
5. Prepare case studies on application of IIoT
6. Understand advanced concepts and applications of industry 4.0

Prerequisite:

1. Knowledge of Mini Project – 1B,
2. Microcontrollers,
3. Skill Based Lab Course,
4. Mini Project 2A Embedded System Project

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to IoT**	1.1 Introduction - Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Sources of IoT, IoT and M2M - IoT/M2M System layers and Design standardization, Difference between IoT and M2M 1.2 Defining Specifications About - Purpose & requirements, process, domain model, information model, service, IoT level, Functional view, Operational view, Device and Component Integration, Application Development, Case Study	4	CO1
II	**Network & Communication aspects**	2.1 Design Principles & Web Connectivity - Web Communication Protocols for connected devices, Web connectivity using Gateway, SOAP, REST, HTTP, RESTful and Web Sockets (Publish — Subscribe), MQTT, AMQP, CoAP Protocols 2.2 Internet Connectivity: - Internet connectivity, Internet based communication, IP addressing in IoT, Media Access Control, Application Layer Protocols. LPWAN Fundamentals: LORA, NBIoT, CAT LTE Ml, SIGFOX, Case Study	8	CO2

III	**Data Management and Analytics for IoT**	3.1 Introduction, Apache Hadoop, Using Hadoop MapReduce for Batch Data Analysis, Apache Oozie, Apache Spark, ApacheStorm, Using Apache Storm for Real-time Data Analysis 3.2 Analysis, Structural Health Monitoring Case Study, Tools for IoT:- Chef, Chef Case Studies, Puppet, Puppet Case Study- Multi-tier Deployment, NETCONF-YANG Case Studies, IoT Code Generator	8	CO3
IV	**Introduction to Industry 4.0**	4.1 Industry 4.0: Managing the Digital Transformation, Conceptual framework for Industry 4.0, Industrial IoT (IIoT) - Introduction, Business Model and Reference Architecture, Industrial IoT- Layers, Sensing, Processing, Communication. 4.2 Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality	8	CO4
V	**Introduction to Industrial IoT (IIoT)**	5.1 Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security, Facility Management. 5.2 Artificial Intelligence, Cybersecurity in Industry 4.0, Internet of Things for Industry 4.0 Design, Challenges and Solutions	6	CO5
VI	**Industry 4.0 Technologies and Applications**	6.1 Internet of Things and New Value Proposition.: Examples for IoTs Value Creation in Different Industries., IoTs Value Creation Barriers: Standards, Security and Provacy Concerns 6.2 Introduction to Industry 5.0, Human Machine Interaction, cognitive computing with human intelligence, Case study on AI based solutions	5	CO6

Text books:

1. ArshdeepBahga and Vijay Madisetti, “Internet of Things: A Hands-on Approach, Universities Press.
2. Raj Kamal, “ Internet of Things: Architecture and Design Principles”, McGraw Hill Education ,First edition
3. Radha Shankarmani, M Vijayalakshmi, ”Big Data Analytics”, Wiley Publications,
4. Andrew Minteer ,”Analytics for the Internet of Things(IoT)”,Kindle Edition
5. Giacomo Veneri , Antonio Capasso,” Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0”, Packt

Suggested reference material (research papers):

1. https://www.mdpi.com/2071-1050/11/16/4371/pdf- Industry 5.0—A Human-Centric Solution – MDPI (open access)
2. https://www.researchgate.net/profile/Mary-Doyle-Kent/publication/336819748_Industry_50_Is_the_Manufacturing_Industry_on_the_Cusp of_a_New_Revolution/links/5e84b810a6fdcca789e5ff75/Industry-50-Is-the-Manufacturing-Industry-on-the-Cusp-of-a-New-Revolution.pdf - Industry 5.0: Is the Manufacturing Industry on the Cusp of a New Revolution?

Reference books

1. Alp Ustundag Emre Cevikcan," Industry 4.0: Managing The Digital Transformation", Springer Series in Advanced Manufacturing
2. G. R. Kanagachidambaresan, R. Anand, E. Balasubramanian, V. Mahima, Internet of Things for Industry 4.0. EAI/Springer Innovations in Communication and Computing
3. The Internet of Things (Connecting objects to the web) by Hakima Chaouchi (Wiley Publications).
4. The Internet of Things (MIT Press) by Samuel Greengard
5. Adrian McEwen, Hakim Cassimally, : Designing the Internet of Things", Paperback,First Edition

Suggested MOOCs:

1. https://onlinecourses.nptel.ac.in/noc20_cs69 - Introduction to Industry 4.0 and Industrial Internet of Things, By Prof. Sudip Misra, IIT Kharagpur
2. https://www.edx.org/course/industry-40-how-to-revolutionize-your-business - Industry 4.0: How to Revolutionize your Business
3. https://onlinecourses.nptel.ac.in/noc21_cs17 - Introduction to internet of things, by Prof. Sudip Misra , IIT Kharagpur
4. https://onlinecourses.nptel.ac.in/noc21_cs08 - Embedded Systems Design
5. By Prof. Anupam Basu, IIT Kharagpur

Recommended list of tools for self learning:

1. Node Red - https://nodered.org/
2. M2MLabs Mainspring - http://www.m2mlabs.com/
3. Tensor Flow - https://www.tensorflow.org/
4. Things Speak - https://thingspeak.com/

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Pract.	Tut.	Total
ETC656	Radar Engineering	**3**	**-**	**-**	**3**	**-**	**-**	**3**

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC656	Radar Engineering	20	20	40	60	2.5	--	--	100

Rationale:

This course introduces learners to the foundational principles and advanced concepts of radar systems, covering everything from the radar equation to real-time plotting and display systems. With rapid advancements in aerospace, defense, navigation, and autonomous systems, understanding radar principles, transmitter-receiver design, signal processing, and tracking techniques is critical. The course is designed to bridge theoretical concepts with real-world applications, preparing students for careers in electronics, communication, aviation, and surveillance technology sectors.

Course Objectives:

1. To explain the basic principles, history, and mathematical foundation of radar including the radar equation and system block diagram.
2. To illustrate the working of MTI and pulse Doppler radar using Doppler effect and signal cancellation techniques.
3. To examine tracking radar principles such as monopulse and conical scan methods and evaluate their accuracy and limitations.
4. To describe the types of radar transmitters, receivers, and industry-standard RF sources focusing on energy efficiency and practical design issues.
5. To analyze the impact of radar clutter and evaluate various radar-assisted landing systems such as ILS, GCA, and MLS.
6. To demonstrate real-time radar plotting techniques, display systems, and the integration of human-machine interfaces in radar visualization.

Course Outcomes:

After successful completion of the course student will be able to:

1. Explain the generalized concept of RADAR & solve problems using radar equations.
2. Describe different types of radar for specific application
3. Explain the concept of tracking radar.
4. Explain the concept of Radar transmitter and receiver.
5. Describe the Radar Clutters and landing system
6. Plot the RADAR target from the given specification.

Prerequisite:

1. Principle of Communication

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to Radar and Radar Equation**	Basics of Radar: Principles, History, and Future Scope Radar Equation: Derivation and Interpretation,Block Diagram of a Basic Radar System,Frequency Bands Used in Radar,Signal Detection in Noise, Receiver Noise Figure, SNR,Probability of Detection and False Alarm,Pulse Repetition Frequency and Its Implications	08	CO1
II	**MTI and Pulse Doppler Radar**	Principles of Doppler Effect and MTI Radar, CW Doppler Radar Concepts,MTI Radar: Block Diagram and Operation,MTI Radar: Block Diagram and Operation,Delay Line Canceller: Theory and Use,Moving Target Detection Concepts,Pulse Doppler	08	CO2

		Radar: Principle and Processing		
III	**Tracking Radar**	Monopulse Tracking: Theory and Angle Measurement,Conical Scan and Sequential Lobing: Comparative Analysis,Tracking Accuracy Limitations,Low-Angle Tracking Considerations	06	CO3
IV	**Radar Transmitters and Receivers**	Industry-Standard RF Sources: Klystron, TWT, Magnetron,Superheterodyne Radar Receiver: Architecture and Performance, Practical Challenges in Radar System Design,Energy Efficiency and Sustainability in Radar Transmitters	06	CO4
V	**Radar Clutters and landing system**	Clutter Types: Surface, Sea, and Land – Impact on Radar Operation,Instrument Landing Systems (ILS),Ground Controlled Approach (GCA),Microwave Landing System (MLS),Radar Altimeters and Their Aviation Use	06	CO5
VI	**Radar Plotting and Display Systems**	Real-Time Radar Plotting Techniques:General Concepts,Passive and Active Plotting Methods in Maritime and Aerial Domains,Industry Displays: PPI, A-Scan, B-Scan, and Modern Visual Interfaces,Human-Machine Interface and Automation in Radar Systems	05	CO6

Text Books:

1. Merill Skolnik,—Introduction to RADAR Systems,Tata McGrawHill, Third Edition
2. Merill Skolnik,—RadarHandbook, TataMcgrawHill, Second Edition
3. Dr. A. K. Sen, Dr. A. B. Bhattacharya- Radar Systems and Radio Aids to Navigation Khanna Publishers

Reference books:

1.Mark A.Richards,James A.Scheer, William A.Holm, —Principles of Modern Radar Basic Principles, Scitech Publishing.
2.SimonKingsley,ShaunQuegon,—UnderstandingRadarSystems‖,ScientechPublishig Inc.
3. G.S. N.Raju, —Radar Engineering and Fundamentals of Navigational Aids‖, I. K International publishing House Pvt.Ltd.
4. Dr. Arjun Singh -Radar Systems and Radio Aids to Navigation,McGraw-Hill Education Private Limited
5. CAPT. H. SUBRAMANIAM- Shipborne Radar And Arpa Nutshell Series Book

Online References:NPTEL / Swayam Course:

Sr. No.	Website Name
1.	NPTEL online Course: https://nptel.ac.in/courses/108/105/108105154/

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract	Tut.	Total
ETL606	Electromagnetics and Antenna Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT 1	IAT 2	Total				
ETL606	Electromagnetics and Antenna Lab	--	--	--	--	25	25	50

Lab Objectives:

The objective of the course is to make student familiar with Maxwell's equation and its usefulness to describe different electromagnetic phenomena such as wave propagation, radiations from antenna etc.

Lab Outcomes:

1) Students will be able to describe electromagnetics field including static and dynamic in terms of Maxwell's equations.
2) Students will be able to apply Maxwell's equation to solve various electromagnetic phenomena such as electromagnetic wave propagation in different mediums, power in EM waves.
3) Students will derive the field equations for the basic radiating elements and describe basic antenna parameters like radiation pattern, directivity, gain etc
4) Students will be able to implement different types of the antenna structures such as

Antenna arrays

5) Design and analyse special types of antenna like Microstrip antenna and reflector antenna etc. and understand their applications.
6) Identify radio wave propagation types in wireless communication channels and understand important phenomena occurring within them.

Prerequisite:

DETAILED SYLLABUS:

Sr. No.	**List of the Experiment**	**Hrs**
1	Study different Antenna parameters (compulsory to use: FSM, Spectrum Analyzer and VNA)	2
2	Introduction to Different Antenna Types	2
3	Study of Wire Antenna, (Radiation pattern of dipole, folded dipole and Monopole antenna, various loops)	2
4	Study of Directive antenna, Yagi-Uda Antenna	2
5	Study of Broad-band Antenna, Log-periodic Antenna	2
6	Study of Antenna Arrays (Broadside, End-fire, Parametric study for various arrays parameters)	2
7	Study of Aperture Antennas (Parabolic/ Hyperbolic/ Horn , with or without Reflector)	2
8	Study of Regular shaped Microstrip Antenna	2
9	Small Project report can be considered as a part of term-work (Design, Simulation and validation)	2
10	Case Study of Recent reported variations of Antenna types (Paper from reputed journal is to be referred and thoroughly study and present the report, maximum four students per group)	2

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practicals' based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical& Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ETL607	Computer Communication Network Laboratory	-	02	-	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract and Oral	Total
		Internal assessment			End Sem. Exam			
		IAT 1	IAT 2	Total				
ETL607	Computer Communication Network Laboratory	--	--	-	-	25	25	50

Lab Course Objectives

1. Introduce students to the practical aspects of networking, including media types, network devices, addressing, and layered architecture as per the OSI and TCP/IP models.
2. Enable hands-on experience with configuring network devices such as routers and switches using simulation tools like Cisco Packet Tracer.
3. Foster practical skills in analyzing and simulating communication protocols such as ARQ, routing protocols, and application layer services using NS2, NetSim, and Wireshark.
4. Develop problem-solving abilities by troubleshooting real-world network issues related to connectivity, addressing, and protocol behavior across OSI layers.
5. Promote project-based learning through the design and simulation of sustainable, secure, and scalable network models.
6. Support career readiness by building competencies essential for roles such as Network Engineer, Network Administrator, and Systems Analyst—aligned with NEP 2020's emphasis on vocational and employable skills.

Lab Course Outcomes

1. Design small to medium-sized computer networks by selecting appropriate transmission media, end devices, and interconnecting components to meet specified user requirements.
2. Configure routers and Ethernet switches for static and dynamic routing protocols (RIP, OSPF, BGP, EIGRP) using industry tools.
3. Develop basic scripts or use simulation tools to demonstrate and test network communication and protocols (e.g., ARQ, TCP, UDP).
4. Simulate real-world network scenarios using tools like Cisco Packet Tracer, NS2, or Wireshark, and analyze protocol behavior and performance metrics.
5. Diagnose and troubleshoot connectivity issues across multiple OSI layers, using both command-line tools and protocol analyzers.
6. Demonstrate technical competence and professional readiness for roles such as Network Engineer, System Administrator, or Network Analyst, in alignment with NEP 2020's skill-based and career-oriented education.

Laboratory plan:

Sr No	List of Experiments	Hrs
1	Use basic networking commands (e.g., ifconfig, ping, netstat, traceroute) on Linux/Netkit.	**02**
2	Prepare and test straight-through and crossover UTP cables using RJ-45 and cable tester.	**02**
3	Design and configure various topologies in Cisco Packet Tracer (Star, Ring, Mesh, Bus).	**02**
4	Configure static routes and analyze routing tables using Cisco Packet Tracer.	**02**
5	Implement RIP, OSPF, BGP, and EIGRP protocols in simulation.	**02**
6	Perform subnetting and VLSM calculations with simulation setup.	**02**
7	Configure DHCP, DNS, FTP, TELNET, or SMTP servers in a simulated environment.	**02**
8	Capture and analyze TCP/UDP headers using Wireshark; perform checksum verification	**02**
9	Compare ALOHA, Slotted ALOHA, CSMA/CD using simulation (e.g., NetSim).	**02**

10	Simulate Stop-and-Wait and Sliding Window ARQ protocols in NS2/C++	**02**
11	Simulate congestion control (TCP Slow Start, Fast Retransmit) using NS2/NS3.	**02**
12	Compare IPv4 vs IPv6 packet structure using packet analysis tools	**02**

Sr.No.	**List of Assignments**	**Hrs.**
1	Network Topologies: Compare and contrast different network topologies (LAN, WAN, MAN, Wi-Fi). OSI Model: Explain the OSI model and its layers, providing examples of each layer's functions.	**01**
2	Explain the functions of protocols like DNS, DHCP, HTTP, FTP, and SMTP.	**01**
3	Analyze a real-world network failure or security breach, identifying causes and proposing solutions.	**01**
4	Design a network architecture for a small business or organization, considering scalability, security, and performance.	**01**
5	Design a Network for a Small Business	**01**
6	Use a network simulator (e.g., Cisco Packet Tracer, NS2) to design and test a network.	**01**

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practicals' based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical& Oral Exam: An Oral & Practical exam will be held based on the above syllabus

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETL608	Image Processing and Machine Vision Laboratory	--	02	--	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT 1	IAT 2	Total				
ETL608	Image Processing and Machine Vision Laboratory	--	--	--	--	25	25	50

Lab Objectives:

1. To teach the fundamentals and mathematical models in digital image processing and Machine Vision
2. To teach quality enhancement of image through filtering operations
3. To teach the students image morphology and restoration techniques
4. To expose the students to segmentation techniques in image processing and Machine Vision
5. To teach the techniques of extracting image attributes like regions and shapes
6. To learn classification and recognition algorithms for machine vision

Lab Outcomes:

After successful completion of the course student will be able to:

1. Demonstrate a comprehensive understanding of the core concepts and mathematical foundations of digital image processing and machine vision.
2. Utilize spatial and frequency domain techniques to effectively enhance image quality, addressing practical imperfections in visual data.
3. Execute image morphology operations and apply restoration algorithms to improve image structure.
4. Implement and compare various image segmentation algorithms, critically evaluating their performance for specific applications.
5. Construct effective representations of image boundaries and shapes, preparing visual data for pattern analysis and recognition.
6. Develop and evaluate object classification and recognition models, demonstrating their utility in automated visual tasks.

List of Experiments.

Sr No	List of Experiments	Hrs
01	Point Processing Methods - Negative, Log, Power law, Contrast stretching, Bit plane slicing	2
02	Histogram calculation and equalization	2
03	Spatial Domain Filtering: 1. Smoothening filters 2. Sharpening with Laplacian 3. Unsharp masking & high boost filtering 4. Edge detection using 1st and 2nd order derivatives	2
04	Frequency Domain Filtering : Ideal, Butterworth and Gaussian	2
05	Morphological operation – Erosion, dilation, opening, closing, hit-miss transform, Boundary extraction	2
06	Image segmentation using global Thresholding Algorithm	2
07	Shape representation using chain code	2
08	Canny edge detection	2
09	Feature extraction using co-occurrence matrix	2
10	Classification using k-means algorithm	2

11	Classification using Basiyan classifier	2
12	Basic binary classification of any data or pattern using Support Vector Machine.	2
13	Case Study : 1. Diseases Prediction 2. Fingerprint identification 3. License plate recognition	2

Sr No	**List of Assignments / Tutorials**	**Hrs**
01	Assignments on fundamental of image processing and Histogram numericals	2
02	Assignment of spatial domain and frequency domain	2
03	Assignment of Segmentation ,feature extraction and ML algorithms	2

Term Work: Term Work shall consist of at least 10 to 12 practicals' based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETL609	Skill Laboratory: Linux & Networking & Server Configuration	-	4	-	-	2	-	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT 1	IAT 2	Total				
ETL609	Skill Laboratory: Linux & Networking & Server Configuration	--	--	--	--	25	25	50

Lab Objectives:

1. Install Linux and implement standard Linux commands
2. Study basic theory of Linux Operating System
3. Implement the system administrative functionality
4. To write shell script programs to solve problems
5. Study basic commands of networking
6. Develop implementation skill of different servers on Linux

Lab Outcomes:

1. Install Linux using a different platform and execute standard Linux commands.
2. Describe the basic knowledge of Linux Operating System
3. Deploy the system administrative functionality
4. Solve the problems using shell script programming
5. Develop network based applications
6. Apply the Linux commands using programming skill to deploy different servers like ftp, telnet etc.

Course pre-requisite:

1) C Programming

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite			
I	**Overview of Linux**	1.1 Installing Software on Debian Based Linux: Debian, Ubuntu, Kali Linux 1.2 Overview of Unix and Linux architectures, Linux files system, Linux standard directories, Linux Directory Structure, Basic Linux Commands, Linux Networking commands, Viewing Files and the Nano Editor, Editing Files in Vi, Graphical Editors, Deleting, Copying, Moving, and Renaming Files	8	CO1
II	**Linux OS**	2.1 Linux Design Principles, Linux Booting Process, Kernel Modules, Process Management, Scheduling, Memory Management, Input and Output, Inter-process Communication.	6	CO2
III	**System Administration**	3.1 Common administrative tasks, Configuration and log files, Role of system administrator, Managing user accounts –adding, deleting users, Changing permissions and ownerships, Creating and managing groups, Modifying group attributes. 3.2 Temporary disabling of users accounts, Creating and mounting file system, becoming super user using su, Getting system information with uname,	8	CO3

		host name. Disk partitions & sizes, users, kernel, installing and removing packages, rpm command		
IV	**Shell programming**	4.1 Basics of shell programming, various types of shell available in Linux, Shell programming in bash, Conditional statements, Looping statements, Case statements, Parameter passing and arguments 4.2 System shell variables, Shell variables, shell keywords, Creating Shell programs for automating system tasks, Scheduling repetitive jobs using cron.	12	CO4
V	**Linux Networking**	5.1 Basics of Network Management, Setting up Dynamic and Static Addressing, Monitoring network services, Talking with DNS Servers, Remote System Administration with OpenSSH-Server & Putty. 5.2 TCP/IP Networking for Linux System Administrators, DNS and hostnames, DHCP, , Network Troubleshooting.	8	CO5
VI	**Servers and Configurations**	6.1 Create and configure DHCP, Mail, DNS, FTP, Squid, Apache, Telnet, Samba servers	10	CO6

List of Experiments.

Sr No	List of Experiments
01	Linux Installation process using following method CD-ROM, Network Installation or Kickstart Installation.
02	Basic commands to create users, change permission, software selection and installation and do changes in Grub file.
03	Practical on configuration of Linux disk Management such as SWAP, LVM, RAID, Primary Partition, Extended Partition and Linux files system.
04	Write a shell script to show various system configuration like currently logged user and his logname, your current shell, home directory, operating system type, current path setting, current working directory, show currently logged number of users, show memory information, Hard disk information like size of hard-disk, cache memory, model etc, and file system mounted.
05	Write a shell script to add user and password on Linux system.
06	Write a shell script to print last login details.

07	Write a shell script to upgrade and cleans the system automatically instead of doing it manually.
08	Write a shell script to delete all log files present inside your var/log directory.
09	Write a script that accepts the hostname and IP address as command-line arguments and adds them to the /etc/hosts file.
10	Write a awk script to find the number of characters, words and lines in a file?
11	Write a shell script that delete all lines containing a specified word
12	Write a shell script to find the factorial of given integer
13	Configuration of DHCP Server and Client
14	Configuration of DNS Server with Domain Name.
15	Configuration of NFS File server and transfer files to a windows client.
16	Setting up a Samba Server and creating a print server.
17	Configuration of Internet Server by creating a Proxy Server and configure browser to use as a proxy.
18	Configuration of Mail Server
19	Configuration of Web Server.
20	Configuration of FTP server and transfer files to demonstrate the working of the same.

Textbooks:

1. YeswantKanethkar – “UNIX Shell Programming”, First edition, BPB.

2. Cristopher Negus – “Red Hat Linux Bible”, Wiley Dreamtech India 2005 edition..

3. Jason Cannon ,”Linux for Beginners: An Introduction to the Linux Operating System and Command line”

4. W. Stevens , Stephen Rago , “Advanced Programming in the UNIX Environment”, Addison- Wesley Professional Computing Series

References:

1. Official Red Hat Linux Users guide by Redhat, Wiley Dreamtech India

2. Graham Glass & King Ables – UNIX for programmers and users, Third Edition, Pearson Education.

3. Neil Mathew & Richard Stones – Beginning Linux Programming, Fourth

edition, Wiley Dreamtech India.

4. Richard Petersen, Linux: The Complete Reference, Sixth Edition

Software Tools:

1. Install Ubuntu desktop | Ubuntu

2. Chapter 4. Quick Installation Guide Red Hat Enterprise Linux 7 | Red Hat Customer Portal

3. Installation | Kali Linux Documentation

Online Repository:

1. How to Install a DHCP Server in Ubuntu and Debian (tecmint.com)

2. How to Install and Configure Postfix as a Send-Only SMTP Server on Ubuntu 16.04 | DigitalOcean

3. Network - DHCP | Ubuntu

Assessment:

Term Work:

At least **12 experiments** covering entire syllabus should be set to have well predefined inference and conclusion. Teacher should refer the suggested experiments and can design additional experiment to maintain better understanding and quality. The experiments should be students centric as well as real time and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every Experiments are graded from time to time.

The grades will be converted to marks as per "Choice Based Credit and Grading System" manual and should be added and averaged. Based on above scheme grading and term work assessment should be done. **The practical and oral examination will be based on entire syllabus.** Students are encourages to share their experiments codes on online repository. **Practical exam should cover all 12 experiments for examination.**

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract	Tut	Total
ETL610	Mini Project 2B: FPGA based Project	-	4$	-	-	2	-	2

$ Indicates work load of a learner (Not Faculty) for Mini Project 2B. Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETL610	Mini Project 2B: FPGA based Project	-	-	-	-	-	25	25	50

Rationale:

The rapid evolution of digital systems and VLSI technology demands engineers proficient in FPGA-based design. This course equips students with hands-on skills in Verilog programming, hardware simulation, and synthesis using industry-standard tools. It bridges the gap between theoretical knowledge and practical hardware implementation. Through mini projects, students learn problem-solving, system integration, and project management. The course ultimately prepares learners for careers in embedded systems, VLSI design, and digital hardware development.

Course Objectives: -

1. To train students for FPGA based project implementation and management
2. To make students VLSI industry ready
3. To make students familiar with the Verilog Programming
4. To make students familiar with the targeted FPGA design and implementation
5. To familiarize students with the numerous FPGA solutions available in Market
6. To familiarize the students with the Interfacing of FPGA boards

Course Outcomes:

1. Understand various FPGA families and method of FPGA synthesis and implementation
2. Learn the working of basic EDA tools like Xilinx, Modelsim cadence , etc
3. Able to program, simulate and synthesize circuits in Verilog HDL.
4. Learn the technique of interfacing of LED, switches and seven segment with FPGA.
5. Learn the project documentation, designing and handling techniques
6. Analysis of FPAG fault detection and verification principles

Prerequisite:

1. Knowledge of Mini Project – 1B,
2. Microcontrollers,
3. Skill Based Lab Course,
4. Mini Project 2A Embedded System Project

Guideline to maintain quality of mini project are as follows:

1. To achieve proper selection of Mini Projects. Students should do survey of FPGA boards, tools and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/ internal committee of faculties.

2. Students shall submit implementation plan in the form of Smart Report/Gantt/PERT/CPM chart, which will cover weekly activity of mini project.

3. A log book to be prepared by each group, wherein group can record weekly work progress, guide/ supervisor can verify and record notes/comments.

4. Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.

5. The solution to be verified with standard tools and procedures and report to be compiled in standard format of University of Mumbai.

6. Suggested steps for mini project selection and implementation

Mini project should be completely FPGA based

Follow these steps

1. Take specification, using these specifications design project.
2. Select proper FPGA considering features and requirements of project. Create UCF file
3. Program it using Verilog and write test benches for verification of each module
4. Test Functional Simulation and verify it using simulation tool
5. Synthesize, map and place and rout the design using synthesis tool
6. Generate bit stream and download on FPGA
7. Verify results on FPGA hardware/hardware setup made for project

Project Topic selection and approval: -

1 The group may be of maximum **FOUR (04)** students.
2 Topic selection and approval by **2 Expert** faculty from department at the start of semester
3 **Log Book** to be prepared for each group to record the work progress in terms of milestones per week by students. Weekly comment, remarks to be put by guiding faculty. Both students and faculty will put signature in it per week. The log book can be managed **online** with proper authentication method using google sheets/forms or open-source project management software.

Project Report Format:

1 Report should not exceed **15 pages**. Simply staple it to discourage use of plastic.
2 The recommended report format is in LaTeX.

Term Work:

1.Term Work evaluation and marking scheme:

. The review/ progress monitoring committee shall be constituted by Head of Departments of each institute.

. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.

. At end of semester the above 2 expert faculty who have approved the topic will internally evaluate the performance.

. Students have to give presentation and demonstration on the FPGA Based Mini Project- 2-B

. In the evaluation each individual student should be assessed for his/her contribution, understanding and knowledge gained about the task completed. Based upon it the marks will be awarded to student.

. Distribution of 25 Marks scheme is as follows:

. Marks awarded by guide/supervisor based on log book : 10

. Marks awarded by review committee : 10

. Quality of Project report : 05

Guidelines for Assessment of Mini Project Practical/Oral Examination:

. Report should be prepared as per the guidelines issued by the University of Mumbai.

. Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and **External Examiners preferably from industry or research organisations** having experience of more than five years approved by head of Institution.

. Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to FPGA and Synthesis**	1.1 Compare FPGA, ASIC, SOC, Basic FPGA architecture, Compare various FPGA Boards**, Understanding VLSI Design flow 1.2 Understanding Tools : Functional simulation , Synthesis and implementation, Synthesis tool flow, Implementation and bit generation, making User constraint files (UCF) 1.3 Study Material : https://www.xilinx.com/support/university/ise/ise-workshops/ise-fpga- design-flow.html	4	CO1
II	**Writing First**	2.1 Introduction to Verilog: Module definition, port declaration, connecting ports,	8	CO2

	program in Verilog	Writing first Testbench 2.2 Exercise : Program for All gates, Writing Test bench and UCF 2.3 Study Material: https://www.xilinx.com/support/university/ise/ise-teaching-material/hdl-design.html		
III	**Combinational design Using VERILOG**	Gate Level Modelling, hierarchical name referencing, Data Flow Modelling: Continuous assignments, delay specification, expressions, operators, operands, operator types Exercise: Programming and FPGA implementation of Adders, 4-bit adders, Mux and decoders, Interfacing LED, switches with FPGA Study Material : https://onlinecourses.nptel.ac.in/noc20_cs63/preview	8	CO3
IV	**Sequential design Using VERILOG**	4.1 Behavioral Modelling : Structured procedures, initial and always, blocking 'and non- blocking statements, delay control, event control, conditional statements, multi way branching, loops, sequential and parallel blocks Advanced topics: Tasks and Functions, generic programming with parameters. 4.1 Exercise: Programming and FPGA implementation of Counters FFs and Shift registers Interfacing Seven Segment Display, UART with FPGA	8	CO4
V	**Project Outline**	5.1 Clocked Synchronous State-Machine Analysis, State-Machine Structure, Output Logic, Characteristic Equations Analysis of State Machines with D Flip-Flops, Clocked Synchronous State-Machine Design, Designing State Machines Using State Diagrams, State Tables 5.2 Project Design Steps: Designing state diagram, block diagram of project, Selection of FPGA for project, Selection of synthesis and simulation tool.	6	CO5
VI	**Project Implementation and management**	6.1 Git Repositories, Learning of Project management software's like CVS, SVN etc 6.2 Project Implementation: Verilog coding, simulation, Synthesis, Bit generation and downloading on FPGA. . 6.3 Result verification and testing	5	CO6

Reference books:

1. Samir Palnitkar, "Verilog HDL A guide to Digital Design and Synthesis" , 2nd Edition, Pearson Education, 2009
2. Simon D Monk, "Programming FPGAs : Getting started with Verilog", 1st Edition, McGraw Hill Eduction- 2016
3. M. Morris Mano, Michael D. Ciletti , "Digital Design: With a Introduction to the Verilog Hdl", Pearson Prentice Hall, 2013
4. David Romano, "Make: FPGAs: Turning Software into Hardware with Eight Fun and Easy DIY", Shroff/Maker Media; First edition,2016
5. Frank Vahid, "Digital Design", Wiley India Private Limited; Preview edition, 2009
6. Behrooz Parhami ,"COMPUTER ARITHMETIC Algorithms and Hardware Designs", , Oxford University Press, 2010
7. Clive Maxfield ,"Design Warrior's Guide to FPGA", 2004, Elsevier

Reference links:

1. https://www.sanfoundry.com/vlsi-questions-answers-aptitude-test/
2. Free Tool : https://www.edaplayground.com/
3. https://github.com/

****Suggested FPGA Hardware Boards:**

1. Numato FPGA boards - https://numato.com/shop/
2. Papilio FPGA boards - http://store.gadgetfactory.net/fpga/
3. CMOD s6 - https://store.digilentinc.com/cmod-s6-breadboardable-spartan-6-fpga-module/
4. TinyFPGA - https://tinyfpga.com/
5. Zync,Zed Board - https://www.xilinx.com/products/silicon-devices/soc/zynq-7000.html
6. Artix -7, Kinetex Boards - https://store.digilentinc.com/arty-a7-artix-7-fpga-development-board/

Suggested Software tools:

1. Xilinx ISE Webpack
2. Modelsim/Questasim
3. Leonardo spectrum
4. MATLAB
5. Quartus
6. Actel
7. Icarus Verilog Simulator

Suggested Projects (FPGA downloading is must)

1. Shift-Add Multiplication,
2. Hardware Multipliers
3. Programmed Multiplication
4. Shift-Subtract Division
5. CORDIC Algorithm
6. Design of functions such as reciprocal, square root, sine, cosine, exponential
7. Wallace Multiplier
8. 8- Bit ALU
9. Matrix Multiplication
10. Booths Multiplier
11. NRZ, NRZI etc coding techniques

Suggested Courses

1. NPTEL Verilog Programming - Free
2. Workshops -Xilinx University Program- Freely available

Suggested Competitions for Funding

1. Government Swadeshi Microprocessor Challenge
2. IICDC – TI challenge
3. Sankalp Semiconductors Hackathons

6. B.E Syllabus

R-2025- B.E Electronics and Telecommunication Engineering

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC701	Microwave Engineering	3	-	-	3	-	-	3

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC701	Microwave Engineering	20	20	40	60	2.5	--	--	100

Rationale : The Microwave Engineering syllabus is designed to provide students with a solid foundation in the analysis, design, and application of microwave-frequency circuits and systems. Covering topics such as transmission lines, waveguides, impedance matching, microwave components, and measurement techniques, this course is essential for careers in radar, satellite communication, wireless systems, and RF design. It combines theoretical understanding with hands-on exposure to simulation tools and measurement equipment used in modern microwave laboratories.

Course Objectives:

1. Perceive the concepts of waveguides and analyze the field components in different types of Waveguides.
2. Categorize different types of microwave components based on their applications.
3. Imbibe knowledge to use microwave oscillators & amplifiers in microwave communication and
4. Compare their characteristics.
5. Demonstrate the ability to measure different microwave parameters using microwave bench setup.

Course Outcomes:

1. Analyze transmission lines and design impedance matching networks using modern tools and Smith charts.
2. Interpret and analyze the field equations of guided media like rectangular waveguides and cavity resonators.
3. Understand the coupling mechanisms in waveguides and analyze the waveguide multiport junctions.
4. Explore the microwave linear tubes and analyze with microwave cross field tubes
5. Understand the microwave solid state devices and avalanche transit time devices
6. Demonstrate the microwave bench set up and conduct measurements of different parameters.

Prerequisite:

1. Knowledge of Electromagnetic Engineering

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**TRANSMISSION LINES**	1.1 Transmission line equations, open and short circuit transmission lines, variation of impedance over length of line, Smith chart, use of Smith chart in impedance matching 1.2 Planar transmission lines: microstrip line, strip line and coplanar lines	6	CO1
II	**WAVEGUIDES**	2.1 Introduction, microwave spectrum and bands, applications of microwaves, Types of waveguides, rectangular waveguides, field equations in rectangular waveguide, field components of TM and TE waves for rectangular waveguide, modes of TM and TE waves in rectangular waveguide, impossibility of TEM waves, cut off frequency of rectangular waveguide; Wave impedance in rectangular waveguide: Wave impedance for a	7	CO2

		TM and TE wave in rectangular waveguide, Dominant mode and degenerate modes, mode characteristics of phase velocity, group velocity, wavelength and impedance relations; Illustrative problems; 2.2 Cavity resonators: Types of cavity resonators; Rectangular cavity resonator: Dominant modes and resonant frequencies, illustrative problems.		
III	**WAVEGUIDE COMPONENTS**	3.1 Coupling mechanisms: Probe, loop, coupling to a cavity resonator, waveguide discontinuities, waveguide irises, tuning screws and posts, matched loads; Waveguide attenuators; Waveguide phase shifters; waveguide 3.2 multiport junctions: E plane Tee, H plane Tee, Magic Tee, applications of Magic Tee, hybrid ring; Ferrites: Faraday rotation principle, gyrator, isolator, circulator 3.3 Wire Elements: Infinitesimal dipole, Wire dipole, Monopole antennas: radiation field derivations and related parameters, Introduction to loop antenna	8	CO3
IV	**MICROWAVE TUBES**	4.1 Microwave linear beam tubes (O type): Limitations of conventional tubes at microwave frequencies; Klystron: Velocity modulation process, bunching process, output power and beam loading; Multicavity Klystron amplifiers: Beam current density, output current and output power of two cavity Klystron; Reflex Klystron: Velocity modulation, power output and efficiency 4.2 Helix Traveling Wave tube: Slow wave structures, amplification process, conventional current; Microwave cross field tubes (M type): Introduction,	10	CO4

		cross-field effects; Magnetrons: Different types, 8-cavity cylindrical travelling wave Magnetron, Hull cut-off and Hartree conditions, modes of resonance and PI-mode operation		
V	**MICROWAVE SEMICONDUCTOR DEVICES**	5.1 Microwave solid-state devices: Microwave tunnel diode; Pin diodes, varactor diodes, crystal detectors. Transferred electron devices: Gunn-effect diodes, RWH theory, modes of operations; Avalanche transit time devices: IMPATT diode, TRAPATT diode, BARITT diode **Self-learning Topics:** **More planar structures**	6	CO5
VI	**MICROWAVE MEASUREMENTS**	6.1 Description of microwave bench: Different blocks and their features, precautions; Microwave power measurement: Bolometers; Measurement of attenuation; Frequency standing wave measurements: measurement of low and high VSWR; Cavity Q; Impedance measurements. **Self-learning Topics:** **Vector Network Analyser**	4	CO6

Text Books:

1. Samuel Y. Liao, ―Microwave Devices and Circuits‖, Pearson, 3rd Edition, 2003.

2. Peter A. Rizzi, ―Microwave Engineering Passive Circuits‖ PHI, 3rd Edition, 1999

3. M.L. Sisodia, G.S.Raghuvanshi, ―Microwave Circuits and Passive Devices‖ Wiley Eastern Ltd., New Age International Publishers Ltd, 1stEdition, 1995.

References:

1. R.E. Collin ―Foundations for Microwave Engineering‖ IEEE Press, John Wiley

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Pract	Tut.	Total
ETC702	Mobile Communication System	3	-	-	3	-	-	3

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC702	Mobile Communication System	20	20	40	60	2.5	--	--	100

Rationale : The Mobile Communication System syllabus is structured to provide students with a comprehensive understanding of cellular communication principles, radio access technologies, and mobility management. Covering key concepts such as GSM, CDMA, LTE, and 5G, the course enables learners to analyze and design mobile networks that meet the growing demand for wireless connectivity. It prepares students for careers in telecommunications by bridging theoretical foundations with practical insights into network architecture, handoff strategies, and quality of service.

Course Objectives:

1. To understand the cellular fundamentals and different types of radio propagation models.

2. To study evolution of 2G and 3G mobile technologies.

3. To illustrate the working principle of LTE.

4. To learn the concepts of emerging technologies for 4 G standards and beyond.

Course Outcomes:

1. Explain the cellular fundamentals and estimate the coverage and capacity of cellular systems.

2. Classify different types of propagation models and analyse the link budget.
3. Compare and contrast GSM, GPRS, HSCSD, EDGE and IS-95 Technologies.
4. Apply the concepts of 3G technologies for UMTS and CDMA 2000.
5. Describe the features and working principle of 3GPP LTE.
6. Discuss the emerging technologies for upcoming mobile communication systems.

Prerequisite:

Principles of Communication Engineering

Digital Communication

Computer Communication and Networks

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	Fundamentals of Mobile Communication	1.Introduction to Wireless Communication: Mobile Radio Telephony, Examples of Wireless Communication Systems 2. The Cellular Concept System Design Fundamentals: Frequency reuse, Channel assignment strategies, Interference and system capacity, Trunking and Grade of service, Improving Coverage and Capacity in Cellular System and related problems.	07	CO1
II	Mobile Radio Propagation	1.Large scale fading: Free space propagation model, ground reflection (two-ray) model, practical Link budget design using path loss models. Self-learning: Basic propagation mechanisms, reflection, diffraction and scattering. 2.Small scale fading: Small-scale multipath propagation, parameters of mobile multipath channels, types of small-scale fading, Rayleigh and Ricean distributions. 3.Features of all conventional multiple access techniques: Frequency Division Multiple	08	CO2

		Access (FDMA), Time Division Multiple Access (TDMA), Space Spectrum Multiple Access (SSMA), Space Division Multiple Access (SDMA), Orthogonal Frequency Division Multiple Access (OFDMA), OFDM-PAPR		
III	2G Technologies	1.GSM: GSM Network Architecture, air interface specifications, GSM signaling protocol architecture, GSM channels, GSM services and features, GSM multifare structure, GSM speech coding, GSM Call procedures, Authentication and security in GSM, and handoff procedures in GSM. 2.GSM evolution: GPRS, HSCSD and EDGE architecture, radio specifications 3.IS-95: CDMA air interface, CDMA channels, power control in CDMA system, handoff, and RAKE receiver.	08	CO3
IV	3G Technologies	1.UMTS: Objectives, standardization and releases, network architecture, air interface specifications, channels, security procedure, W-CDMA air interface, attributes of W-CDMA system, W-CDMA channels. 2.Cdma2000 cellular technologies: Forward and Reverse Channels, Handoff and Power Control.	05	CO4
V	3GPP LTE	1.Introduction, system overview: Frequency bands and spectrum flexibility, network structure, protocol structure. 2.Physical layer: Frames, slots, and symbols, modulation, coding, multiple-antenna techniques 3.Logical and Physical Channels: Mapping of data onto (logical) sub-channels, Establishing a connection, Physical layer retransmissions and reliability, Power control, and handover.	06	CO5
VI	Advanced techniques for 4G deployment and beyond	1. Multi-antenna Techniques: Smart antennas, Multiple input Multiple output systems 2. Cognitive radio: Architecture, spectrum sensing. Software Defined Radio (SDR): Components and Applications. 3. Introduction to 5G network and technologies used in 5G such as small cell	05	CO6

		concept, Massive MIMO, Beamforming, NOMA, and mm wave).		

Text Books:

1. T. L. Singal “wireless communications”, Mc Graw Hill Education.

2. Theodore S. Rappaport “wireless communications - principles and practice”, PEARSON, Second edition.

3. Andreas F. Molisch “wireless communications” WILEY INDIA PVT LTD, Second edition.

References:

1. Upena Dalal “Wireless and Mobile Communications‖”, Oxford university Press

2. Vijay K.Garg “Wireless Communications and Networking” ,Morgan–Kaufmann series in Networking-Elsevier.

3. J. H. Reed, Software-Defined Radio, Prentice-Hall, 2002

4. W. C. Y. Lee, Mobile Communication, Wiley

5. David Tse, Pramod Viswanath “Fundamentals of Wireless Communication” published by Cambridge University Press

Online References:

Sr. No.	**Website Name**
1.	NPTEL courses: http://nptel.ac.in/courses/117104099/ - (Advanced 3G and 4G Wireless Mobile communications)
1.	https://nptel.ac.in/courses/117/102/117102062/
3.	Virtual lab: http://vlab.co.in

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC731	Efficient Architectures for DSP Algorithms	03	--	--	03	--	--	03

		Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term work	Pract / Oral	Total
		Internal assessment			End Sem. Exam				
		IAT 1	IAT 2	Total					
ETC731	Efficient Architectures for DSP Algorithms	20	20	40	60	2.5	--	--	100

Rationale: The Efficient Architectures for DSP Algorithms syllabus is designed to provide students with an in-depth understanding of hardware-efficient implementations of digital signal processing techniques. The course emphasizes algorithm-architecture co-design, exploring pipelining, parallel processing, and low-power VLSI architectures for real-time signal processing applications. It equips learners with the skills to optimize performance, area, and power in DSP systems critical for applications in communications, multimedia, and embedded systems.

Course Objectives:

1. To describe the characteristics of computationally intensive algorithms
2. To identify the bottlenecks of intensive computations.
3. To learn various techniques to map DSP algorithms on hardware to improve performance.

Course Outcome:

1. Understand and analyze the structure and behavior of typical DSP algorithms using signal/data flow graphs and critical path evaluation.
2. Design efficient hardware architectures for basic arithmetic operations such as incrementers, decrementers, and optimized logic for various DSP functions.
3. Evaluate and implement delay-optimized adder architectures including Carry Look Ahead, Carry Select, Conditional Sum, Ling's and Prefix Adders.
4. Analyze and design efficient multiplier architectures such as Booth's, Baugh-Wooley, and reconfigurable constant multipliers for DSP applications.
5. Apply concepts of floating-point arithmetic and advanced architectures such as CORDIC, FFT, and FIR filters in DSP hardware implementation.
6. Design and optimize energy-efficient hardware accelerators for machine learning applications using techniques like pruning, systolic arrays, and RTL modeling.

Course Prerequisite:

Digital System Design
Discrete Time Signal Processing
Digital VLSI Design
Mini Project 2B- FPGA based Project

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to DSP Systems**	Typical DSP Algorithms, Graphical representation of DSP Algorithms ,Signal flow graph (SFG), data flow graph (DFG) and dependence graph (DG), high level transformation, critical path	6	CO1
II	**Efficient Algorithm to**	Design of N-bit incrementer, decrementer, complimenter , Techniques to enhance	7	CO2

	Architecture Mapping	circuit performance, pipelining and parallel processing, circuit designfor N bit natural numbers, optimized circuit design for different functions		
III	**Efficient Adder Architecture**	Introduction to Adder design, Variable Block Adder circuit design, Delay optimized Carry Look Ahead Adder, Carry Select Sum Adder, Conditional Sum Adder, Ling's Adder, Prefix and Parallel prefix adders, Running Average Circuit	7	CO3
IV	**Efficient Multiplier Design**	Array Multiplier ,Signed and Unsigned Multiplier ,Booths Multiplier , Bough-Wooley Multiplier, Architecture of Squaring Circuit, Reconfigurable Constant Multiplier Design	7	CO4
V	**DSP Architecture Design**	Floating point representation IEE754, floating point operations-2's compliment representation, adder, subtractor, multiplier, CORDIC Architecture, FFT Architecture, FIR filter	6	CO5
VI	**Efficient Design of Machine Learning Hardware**	Artificial Intelligence and Machine Learning, Software and Co-design Optimizations, Pruning, Systolic array convolution, Hardware-Level Techniques, RTL design of sum of differences, Energy efficient hardware accelerator design methodology for Neural Networks	6	CO6

Textbooks:

1. VLSI Digital Signal Processing Systems Design and Implementation – Khesab Parhi

2. COMPUTER ARITHMETIC Algorithms and Hardware Designs-Behrooz Parhami

3. Machine Learning in VLSI-Ibrahim (Abe) M. Elfadel, Duane S. Boning, Xin Li Computer-Aided Design

Reference Books:

1. Bill Franks, ―Taming The Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics‖, Wiley
2. Chuck Lam, ―Hadoop in Action‖, Dreamtech Press

E-Resources:

1. https://nptel.ac.in/courses/108105118
2. https://nptel.ac.in/courses/108106149
3. https://nptel.ac.in/courses/108105157

Course Code	Course Name	Teaching Scheme (Contact Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETC732	Deep Learning	03	--	--	03	--	--	03

		Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term work	Pract / Oral	Total
		Internal assessment			End Sem. Exam				
		IAT 1	IAT 2	Total					
ETC732	Deep Learning	20	20	40	60	2.5	--	--	100

Rationale : The Deep Learning syllabus is designed to provide students with a solid foundation in the fundamental concepts and techniques of neural networks, enabling them to develop, train, and evaluate deep learning models. With increasing real-world applications in image recognition, natural language processing, and autonomous systems, the course prepares students for advanced research and practical deployment of AI technologies.

Course Objectives:

1. Learn the fundamentals of Deep Learning.
2. Learn how to use TensorFlow for building and testing Deep Learning models
3. Compare various CNN architectures
4. Know the importance of Regularisation and Optimization techniques in Deep Learning networks
5. Learn Deep Learning models for working with sequential data
6. Understand motivation and functioning of the most common types of Autoencoders and apply such mechanisms to various learning problems.

Course Outcomes:

1. Understand the fundamentals of Deep Learning
2. Understand the concepts of TensorFlow, its main functions, operations and the execution pipeline
3. Improve deep learning models using Regularization and Optimization techniques
4. Compare the Convolution Neural Network architectures and use them as per the application
5. Design and implement Sequence Neural Network systems and solve real-world problems
6. Illustrate the working of Autoencoders and use them for real-life applications

Prerequisite:

Artificial Neural Networks and Fuzzy logic

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to Deep learning**	History of Deep Learning- A Probabilistic Theory of Deep Learning , Introduction to Deep Feedforward Networks, Gradient Based Learning, Hidden Units, Architecture Design, Backpropagation Algorithm. **Self-learning Topics:** Activation Functions, Loss Functions, Vanishing/Exploding Gradients.	3	CO1
II	**TensorFlow for Deep learning**	Introduction to TensorFlow using Python: Computational Graph, Key Highlights, Creating a Graph, Regression example, Gradient Descent, TensorBoard, Modularity, Sharing Variables, Keras, Preprocessing and Data Augmentation of Images and Datasets using TensorFlow **Self-learning Topics: Tensorflow Library**	6	CO2
III	**Regularization and Optimization Techniques**	**Regularization:** Need of Regularization, L2 Regularization,L1 Regularization, Early Stopping and Dropout, **Optimization:** Challenges in NN Optimization, Gradient Descent	6	CO3

		Approaches, Parameter Initialization Approach, Adaptive Approaches - AdaGrad, RMSProp and Adam Introduction to Batch Normalization **Self-learning Topics:** Deep learning applications in Object Localization, Video Classification, Different optimizers techniques		
IV	**Evolution of CNN in Deep Learning**	Review of CNN Architecture, Introduction of various CNN Architectures: LeNet, AlexNet, VGG, GoogleNet, ResNet and UNet, Comparison of CNN Architectures, Evaluation Parameters, Applications of CNN in Image Classification and Object Detection. **Self-learning Topics:** Recommender System, End-to-End Speech Recognition and Machine Translation	8	CO4
V	**Sequence Modeling**	Recurrent and Recursive Nets: Recurrent Neural Networks, Bidirectional RNN, Encoder Decoder Architectures , Introduction to Long Short-Term Memory (LSTM) andTemporal Dependencies, Gated Recurrent Units (GRUs), Applications of RNN in Real World- Image Captioning and Time Series Forecasting and Prediction **Self-learning Topics:** Attention Mechanism	8	CO5
VI	**Encoder Decoder Models**	Autoencoder: Encoder-Decoder Model, Training & Learning Manifold Space, Regularized Autoencoders: Sparse, De-noising and Contractive, Deep Autoencoder: Architecture and Working, Variational Autoencoders: Limitations of Autoencoders, Loss Function, Re-parameterization Trick, Latent Space Visualization, Applications of Autoencoders and Variational Autoencoders-Dimensionality Reduction , Image De-noising and Compression **Self-learning Topics:** GANs vs Autoencoders	8	CO6

Text Books:

1. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer International Publishing, 2018.
2. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016.

Reference books

1. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer-Verlag, 2006.
2. Duda, Richard, Peter Hart, and David Stork, Pattern Classification, 2nd edition, Wiley-Interscience, 2000.
3. Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.
4. Reza Zadeh, Bharath Ramsundar, TensorFlow for Deep Learning, 1st edition, O'Reilly Media Inc, 2018.
5. Zaccone, Giancarlo, Deep Learning with TensorFlow, 2nd edition, Packt Publishing, 2018.

NPTEL / Swayam Courses:

1. NPTEL course on Deep learning by Prof. Sudarshan Iyengar, IIT Ropar. https://nptel.ac.in/courses/106/106/106106184/
2. NPTEL course on Deep learning by Prof. Prabir Kumar Biswas, IIT Kharagpur. https://nptel.ac.in/courses/106/105/106105215/
3. NPTEL Course on Practical Machine Learning with TensorFlow by Prof. Balaraman Ravindran, IIT Chennai. https://nptel.ac.in/courses/106/106/106106213/

Online Resources:

1. https://www.tensorflow.org/tutorials/images/data_augmentation
2. https://towardsai.net/p/machine-learning/improving-artificial -neural-network- with-regularization-and-optimization
3. https://towardsdatascience.com/regularization-techniques-for-neural-networks- e55f295f2866
4. https://www.kaggle.com/sid321axn/regularization-techniques-in-deep-learning
5. https://medium.com/@minions.k/optimization-techniques-popularly-used-in- deep-learning-3c219ec8e0cc
6. https://www.jeremyjordan.me/variational-autoencoders/

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC733	Cloud Computing and Security	03	--	--	03	--	--	03

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC 733	Cloud Computing and Security	20	20	40	60	2.5	--	--	100

Rationale : The Cloud Computing syllabus is designed to equip students with the knowledge and skills required to understand, design, and implement scalable, reliable, and cost-efficient cloud-based solutions. As cloud technologies become central to modern IT infrastructure and services, this course prepares learners for roles in cloud architecture, deployment, and security using leading platforms such as AWS, Azure, and Google Cloud. It bridges theoretical foundations with practical applications in virtualization, service models, and distributed computing.

Course Objectives:

1. Understand the fundamentals of cloud computing .
2. Appreciate the importance of virtualization in cloud computing
3. Understand various cloud computing services and platforms
4. Understand application design concepts in cloud
5. Understand the security aspects of cloud computing
6. Understand the advances in cloud computing

Course Outcomes:

1. Explain the fundamentals of cloud computing.
2. Interpret the significance of virtualization in the context of cloud computing
3. Describe cloud computing services working on AWS, Azure and Google cloud platforms

4. Explain application design aspects of cloud computing
5. Interpret security aspects to cloud computing.
6. Explain advances in cloud computing in terms of multimedia cloud, fog, edge computing and real applications of cloud.

Prerequisite:

Computer Communication Network

Digital Encryption System

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to Cloud**	Introduction to Cloud Computing, Cloud Characteristics, Cloud Computing Components, Comparing of Cloud Computing with Peer to Peer architecture, Client Server , Distributed, Grid, Cloud Deployment model (Cloud types- Public, Private, Community, Hybrid), Service Models-(IaaS,PaaS,SaaS,)	4	CO1
II	**Virtualization**	Introduction & benefit of Virtualization – Implementation Levels of Virtualization- VMM Design Requirements and Providers – Virtualization at OS level – Middleware support for Virtualization– Virtualization structure/tools and mechanisms: Hypervisor and Xen Architecture, Binary Translation with full Virtualization, Para Virtualization with Compiler Support - Virtualization of CPU, Memory and I/O Devices, Hardware support for Virtualization in intel x86 processor – CPU Virtualization – MemoryVirtualization and I/O Virtualization – Virtualization in Multicore processors **Self-learning Topics: Tensorflow Library**	7	CO2

III	**Cloud Computing Services**	Compute Services - Amazon Elastic Compute Cloud, Google Compute Engine, Windows Azure Virtual Machines Storage Services - Amazon Simple Storage Service, Google Cloud Storage, Windows Azure Storage Database Services - Amazon Relational Data Store, Amazon DynamoDB, Google Cloud SQL, Google Cloud Datastore, Windows Azure SQL Database, Windows Azure Table Service Application Services - Application Runtimes & Frameworks, Queuing Services, Email Services, Notification Services, Media Services, Content Delivery Services - Amazon CloudFront, Windows Azure Content Delivery Network Analytics Services - Amazon Elastic MapReduce, Google MapReduce Service, Google BigQuery, Windows Azure HDInsight Deployment & Management Services - Amazon Elastic Beanstalk, Amazon CloudFormation Identity & Access Management Services - Amazon Identity & Access Management, Windows Azure Active Directory Open Source Private Cloud Software - CloudStack, Eucalyptus, OpenStack	10	CO3
IV	**Cloud Application Design**	Design Considerations for Cloud Applications - Scalability, Reliability & Availability, Security, Maintenance & Upgradation, Performance, Cloud Application Design Methodologies - Service Oriented Architecture, Cloud Component Model, IaaS, PaaS and SaaS services for cloud applications, Model View Controller, RESTful Web Services, Data Storage Approaches - Relational (SQL) Approach, Non-Relational (No-SQL) Approach **Self-learning Topics:** Recommender System, End-to-End Speech Recognition and Machine Translation	6	CO4

V	**Cloud Security**	Security for Virtualization Platform – Host security for SaaS, PaaS and IaaS – Data Security – Data Security Concerns – Data Confidentiality and Encryption – Data Availability –Data Integrity – Cloud Storage Gateways – Cloud Firewall, AAA Administration for Clouds -AAA model – SSO for Clouds – Authentication management and Authorization management in clouds – Accounting for Clouds Resource utilization.	6	CO5
VI	**Cloud Computing Applications**	Cloud Computing for Health care, Education, Transportation, Manufacturing Industry, Energy System, Mobile Computing Multimedia Cloud - Introduction, Streaming Protocols - RTMP Streaming, HTTP Live Streaming, HTTP Dynamic Streaming Case Studies - Live Video Streaming App , Video Transcoding App, Edge Computing, FOG Computing	6	CO6

Text books :

1. Cloud Computing - A Hands-on Approach - Arshdeep Bahga and Vijay K. Madisetti
2. Mastering Cloud Computing: Foundations and Applications Programming Paperback – by Rajkumar Buyya , Christian Vecchiola , S.Thamarai Selvi , Publisher: Morgan Kaufmann
3. Amazon Web Services For Dummies (For Dummies Series) Paperback by Bernard Golden, Publisher: John Wiley & Sons
4. “The Cloud Computing Book: The Future of Computing Explained” , Douglas E. Comer
5. Cloud Computing for Dummies, Judith Hurwitz Daniel Kirsch

Reference books

1. Cloud Computing Black Book : Kailash Jayaswal, Jagannath Kallakurchi, Donald J. Houde, Dr. Deven Shah by Kogent Learning Solutions , Publisher : Dreamtech Press
2. Cloud Computing Concepts Technology and Architecture - Erl second hand book online from UsedBooksFactory
3. Practical Cloud Security by Chris Dotson, Publisher(s): O'Reilly Media, Inc. ISBN: 9781492037514
4. AWS Whitepapers & Guides https://aws.amazon.com/whitepapers/
5. Azure whitepapers https://azure.microsoft.com/en-in/resources/whitepapers/

6. Google Cloud whitepapers https://cloud.google.com/whitepapers

NPTEL / Swayam Courses:

1. NPTEL Swayam Course on Cloud computing By Prof. Soumya Kanti Ghosh https://nptel.ac.in/courses/106/105/106105167/
2. Cloud Computing and Distributed Systems By Prof. Rajiv Misra https://onlinecourses.nptel.ac.in/noc22_cs18/preview
3. Google Cloud Computing Foundation Course https://nptel.ac.in/courses/106/105/106105223

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC734	Big Data Analytics	03	--	--	03	--	--	03

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC734	Big Data Analytics	20	20	40	60	2.5	--	--	100

Rationale :

In the era of digital transformation, vast amounts of data are generated daily across industries. Big Data Analytics equips students with the skills to process, analyze, and derive insights from large and complex datasets, enabling data-driven decision-making and innovation in fields such as engineering, healthcare, finance, and smart systems.

Course Objectives:

1. To provide an overview of Big Data, its characteristics, challenges, and significance in modern data-driven industries.
2. To introduce key tools and technologies used for Big Data processing, including Hadoop and its ecosystem.
3. To familiarize students with NoSQL databases and their application in managing unstructured and distributed data.
4. To impart knowledge of the MapReduce programming model and its use in processing large-scale data.
5. To explore analytical techniques such as similarity search, stream mining, link analysis, and frequent pattern mining for extracting insights.
6. To demonstrate real-world applications of Big Data in areas like recommendation systems and social network analysis.

Course Outcomes:

1. Understand the characteristics, challenges, and business applications of Big Data to illustrate its impact on traditional data processing.
2. Demonstrate the architecture, ecosystem components, and limitations of Hadoop for scalable data storage and processing.
3. Classify and compare NoSQL data models and architectural patterns suitable for managing unstructured Big Data.
4. Construct data processing algorithms using the MapReduce paradigm and evaluate their efficiency in distributed environments.
5. Apply analytical techniques like similarity search, stream mining, link analysis, and frequent item set mining for Big Data insights.
6. Develop recommendation systems and analyze social network data using clustering and graph-based approaches.

Prerequisite: Basic knowledge of Database Management System

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite**	Basic knowledge of Database Management System	1	
I	**Introduction to Big Data Analytics**	1.1 Introduction to Big Data, Big Data characteristics, Types of Big Data, Traditional vs. Big Data a business approach 1.2 Technologies Available for Big Data, Infrastructure for Big Data, Big Data Challenges, Case Study of Big Data Solutions.	3	CO1
II	**Hadoop**	Introduction to Hadoop. Core Hadoop Components, Hadoop Ecosystem-Apache HBase, Hive, HCatalog, Pig, Mahout, Oozie, Zookeeper, Sqoop, Physical Architecture, Hadoop limitations.	5	CO2
III	**NoSQL**	3.1Introduction to NoSQL, NoSQL business drivers, NoSQL database case studies 3.2 NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, Variations of NoSQL architectural patterns	6	CO3

		3.3Using NoSQL to manage big data: What is a big data NoSQL solution? Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; Four ways that NoSQL systems handle big data problems Managing MongoDB database with CRUD operations.		
IV	**MapReduce**	4.1 MapReduce and The New Software Stack: Distributed File Systems, Physical Organization of Compute Nodes, Large Scale File-System Organization. 4.2 MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures 4.3 Algorithms Using MapReduce: MapReduce WordCount Program, Matrix-Vector Multiplication by MapReduce , Relational-Algebra Operations by MapReduce, Matrix Operations, Matrix Multiplication by MapReduce.	6	CO4
V	**Techniques in Big Data Analytics**	5.1 Finding Similar Item: Nearest Neighbor Search, Similarity of Documents, Distance Measures: Euclidean, Jaccard , Cosine , Edit and Hamming Distance with its Examples 5.2 Mining Data Streams: Data Stream Management Systems, Data Stream Model, Examples of Data Stream Applications: Sensor Networks, Network Traffic Analysis Filtering streams: The Blooms filter. 5.3 Link Analysis: PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: Page Rank Implementation Using MapReduce 5.4 Frequent Itemset Mining: Market-Basket Model, Apriori Algorithm, Algorithm of Park-Chen-Yu	13	CO5
VI	**Big Data Analytics Applications**	6.1 Recommendation Systems: Introduction, A Model for Recommendation Systems: Collaborative-Filtering System, Content based system and its Examples.	6	CO6

		6.2 Mining Social-Network Graphs: Social Networks as Graphs, Types of Social-Network. Clustering of Social Graphs: Applying Standard Clustering Techniques, Counting triangles using MapReduce. **Self-learning Topics:** "Introduction to Apache Spark: Architecture, RDDs, and Comparison with MapReduce"		

Text Books:

1. Radha Shankarmani and M Vijayalakshmi —Big Data Analytics‖, Wiley
2. Alex Holmes —Hadoop in Practice‖, Manning Press, Dreamtech Press.
3. Dan McCreary and Ann Kelly —Making Sense of NoSQL – A guide for managers and the rest of us, Manning Press.

References:

1. Bill Franks, —Taming The Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics‖, Wiley
2. Chuck Lam, —Hadoop in Action‖, Dreamtech Press

Online References:

Sr. No.	Website Name
1.	https://www.analyticsvidhya.com/blog/2014/05/hadoop-simplified
2.	https://www.analyticsvidhya.com/blog/2014/05/introduction-mapreduce/
3.	https://www.pdfdrive.com/data-science-and-big-data-analytics-e58447171.html
4.	https://www.pdfdrive.com/big-data-analytics-a-hands-on-approach-e158549112.html

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC735	Software Defined Radio	03	--	--	03	--	--	03

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC 735	Software Defined Radio	20	20	40	60	2.5	--	--	100

Rationale : The Software Defined Radio syllabus is designed to introduce students to the flexible and reconfigurable design of radio communication systems using software rather than traditional hardware components. By covering topics such as digital modulation, signal processing, RF front-end design, and SDR platforms like GNU Radio and USRP, this course equips learners to prototype and implement modern wireless systems, including 5G, cognitive radio, and IoT. It bridges theory and hands-on practice, fostering innovation in dynamic and adaptive communication technologies.

Course Objectives:

1. To introduce fundamental knowledge of Software Defined Radio (SDR) and Cognitive Radio (CR) technology in next generation networks.
2. To introduce the hardware and software requirements and design aspects of CR
3. To introduce the architecture, spectrum sensing, spectrum awareness and allocation in CR networks.
4. To introduce the various standards available in CR technology and GNU platform for experimentation.

Course Outcomes: After learning the course the students will be able to demonstrate the ability

1. To Learn the hardware and software architecture and various design principles of SDR
2. To understand challenges of receiver design and select suitable hardware and software for SDR.
3. To understand the functions, components and challenges of CR technology for better spectrum exploitation.
4. To analyze various spectrum sensing techniques in CR environment.
5. To understand and apply the techniques of dynamic spectrum allocation and scheduling in CR based networks.
6. To understand various standards of CR Technology and its role in next generation networks and GNU platform.

Prerequisites:

Computer Communication and Networks
Mobile Communication Systems

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite**	Basic knowledge of Database Management System	1	
I	**Software Defined Radio**	Basic components of Software Defined Radios, Software defined radio hardware Architectures, Distortion parameters - Sources and metrics of distortion in a transceiver, Nonlinear distortion and nonlinearity specifications, Power amplifiers: Nonlinear Distortion in Transmitted Signals	5	CO1
II	**SDR Architecture and Components**	Power amplifier Line-up for linearity & power requirement calculations, Linearization Techniques for nonlinear distortion in SDR, Pre distortion Techniques for nonlinear distortion in SDR, Digital Pre distortion Techniques for Linear/Nonlinear Distortion, SDR Software architecture, Software Tunable Analog Radio Components, Antenna Systems, Reconfigurable Digital Radio Technologies, Basic Digital Radio Components	8	CO2

III	**Cognitive Radio**	**Cognitive radio features and capabilities**: Cognitive radio architecture Functions of cognitive radio Dynamic spectrum access, Components of cognitive radio Interference temperature ,Spectrum sensing,Spectrum analysis and spectrum decision, **Research challenges in Cognitive Radio:** Issues in spectrum sensing, Spectrum management issues Spectrum mobility issues , Network layer and transport layer issues, Cross-layer design for cognitive radio networks, Artificial intelligence approach for designing cognitive radio, Location-aware cognitive radio	6	CO3
IV	**Spectrum Sensing for Cognitive Radio**	Challenges, Matched Filtering, Waveform-Based Sensing, Cyclostationarity -Based Sensing, Energy Detector-Based Sensing, Radio Identification, Cooperative Sensing, External Sensing, Statistical Approaches and Prediction, Sensing Frequency, Hardware Requirements and Approaches, Multi-dimensional Spectrum Awareness	6	CO4
V	**Dynamic spectrum access and management in Cognitive Radio**	Spectrum access models : Exclusive-use model , Shared-use model Spectrum commons model Dynamic spectrum access architecture:Infrastructure-based versus infrastructure less cognitive radio network Centralized versus distributed dynamic spectrum access Inter- and intra-RAN dynamic spectrum allocation Optimal decision on spectrum sensing and spectrum access Multichannel and multi user MAC Spectrum allocation and scheduling, Spectrum trading Performance analysis of cognitive MAC protocols	8	CO5
VI	**Advanced topics in Cognitive Radio**	Cognitive radio architectures for NeXt Generation (XG) networks, Cognitive radio standardization : IEEE SCC 41, IEEE 802.22 for wireless regional area networks (WRANs), GNU Radio for cognitive radio experimentation	6	CO6

TextBooks:

1. Huseyin Arslan, "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems", Springer, 2007
2. Ekram Hossain, Dusit Niyato, Zhu Han, "Dynamic Spectrum Access and Management in Cognitive Radio Networks", Cambridge University Press, 2009
3. Bruce Fette, "Cognitive radio technology", Elsevier, 2nd edition, 2009.
4 Alexandar M Wylingskey, Maziar Nikovee, Y Thomas Hou, "Cognitive Radio Communications and Networks Principles and Practice", Elsevier, 2010

References:

1. Kwang-Cheng Chen, Ramjee Prasad, "Cognitive radio networks", John Wiley & Sons Ltd., 2009.
2. Francisco Rodrigo Porto Cavalcanti, Soren Andersson, "Optimizing Wireless Communication Systems" Springer, 2009.
3. Linda Doyle, "Essentials of Cognitive Radio", Cambridge University Press, 2009.

E-Resources:

1. NPTEL: https://nptel.ac.in/courses/108/107/108107107/
2. GNU Radio: https://www.gnuradio.org/
3. https://wiki.gnuradio.org/index.php/Tutorials
   http://www.gcndevelopment.com/gnuradio/downloads.htm

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC741	**Robotics**	**3**	**-**	**-**	**3**	**-**	**-**	**3**

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC 741	**Robotics**	20	20	40	60	2.5	--	--	100

Rationale : The Robotics syllabus is designed to provide students with a multidisciplinary foundation in mechanical design, electronics, sensors, actuators, control systems, and embedded programming essential for building intelligent robotic systems. As robotics increasingly impacts industries like manufacturing, healthcare, defense, and automation, this course enables learners to design, simulate, and control autonomous robots while fostering innovation and problem-solving. It also prepares students for advanced research and practical applications in real-world robotic systems.

Course Objectives:

1. To introduce the functional elements of Robotics
2. To impart knowledge on the direct and inverse kinematics
3. To introduce the manipulator differential motion and control
4. To educate on various path planning techniques
5. To introduce the dynamics and control of manipulators
6. To study about the localization, planning and navigation

Course Outcomes:

After successful completion of the course students will be able to

1. Explain basic concept of robotics.
2. Describe the differential motion, add statics in robotics
3. Describe the various path planning techniques.

4. Describe the dynamics and control in robotics industries.
5. Write program to use a robot for a typical application
6. Use Robots in different applications

Prerequisite:

1. Knowledge of Engineering Mathematics III and IV

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**BASIC CONCEPTS**	1.1 Brief History 1.2 Types of Robot–Technology-Robot classifications and specifications 1.3 Design and Control issues 1.4 Various manipulators 1.5 Sensors , work cell 1.6 Programming languages	3	CO1
II	**DIRECT AND INVERSE KINEMATICS**	2.1 Mathematical representation of Robots - Position and orientation 2.2 Homogeneous transformation Various joints, Degrees of freedom 2.3 Representation using the Denavit Hattenberg parameters 2.4 Direct kinematics-Inverse kinematics 2.5 Solvability – Solution methods-Closed form solution 2.6 SCARA robots-	8	CO2
III	**PATH PLANNING**	3.1 Joint space technique 3.2 Use of p-degree polynomial, Cubic polynomial, Cartesian space technique 3.3 Parametric descriptions 3.4 Straight line and circular paths 3.5 Position and orientation planning	8	CO3
IV	**DYNAMICS AND CONTROL**	4.1 Lagrangian mechanics 4.2 2DOF Manipulator 4.3 Lagrange Euler formulation 4.4 Dynamic model 4.5 Manipulator control problem-Linear control schemes-PID control scheme-Force control of robotic manipulator	7	CO4
V	**SERVICE ROBOTICS**	5.1 Need for service robots 5.2 LOCALIZATION: Challenges of Localization- Map Representation-Probabilistic Map based Localization Monte carlo localization- Landmark based	7	CO5

		navigation-Globally unique localization-Positioning beacon systems- Route based localization 5.3 PLANNING AND NAVIGATION: Path planning overview, Cell decomposition path planning Potential field path planning-Obstacle avoidance		
VI	**APPLICATIONS**	6.1 Ariel robots 6.2 Collision avoidance 6.3 Robots for agriculture, mining, exploration, underwater, civilian and military applications, nuclear applications, Space applications 6.4 Humanoids	6	CO6

Text Books:

1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005.
2. JohnJ.Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009.
3. M.P.Groover, M.Weiss, R.N. Nageland N. GOdrej, Industrial Robotics, McGraw-Hill Singapore, 1996.
4. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, „Introduction to Autonomous Mobile Robots", Bradford Company Scituate, USA, 2004

References:

1. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
2. K. K.Appu Kuttan, Robotics, I K International, 2007.
3. Edwin Wise, Applied Robotics, Cengage Learning, 2003.
4. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers,Chennai, 1998
5. Riadh Siaer, „The future of Humanoid Robots- Research and applications, Intech Publications, 2012.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC742	5G Technology	03	--	--	03	--	--	03

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC742	5G Technology	20	20	40	60	2.5	--	--	100

Rationale : 5G (Fifth Generation) technology is the next step in mobile telecommunications, offering transformative improvements over previous generations (3G, 4G LTE). Its development is driven by the growing need for faster, more reliable, and more efficient communication to support emerging technologies and societal demands.

Course Objectives:

1. Learn the basics of 5G and beyond wireless communication
2. Study 5G network architecture and Heterogeneous Network and Small cells
3. Provide understanding of the key technologies and enablers of 5G and beyond communication systems.
4. Learn 5G technology like massive MIMO, mmWave etc.

Course Outcomes:

1. Explain the evolution of wireless networks and the key features, requirements, and services of 5G and 5Gi.
2. Analyze the 5G network architecture including Heterogeneous Networks, Cloud RAN, small cell deployments, and mobility management strategies.
3. Evaluate mmWave technologies, physical layer challenges, channel modeling, and beamforming techniques used in 5G networks.
4. Differentiate between orthogonal and non-orthogonal multiple access schemes (e.g., NOMA) and assess their relevance in 5G systems.

5. Apply cognitive radio techniques for spectrum optimization and interference management in 5G heterogeneous networks.
6. Assess the impact of emerging 5G technologies and trends (e.g., Open RAN, URLLC, mMTC, IIoT, AR/VR, and Tactile Internet) on real-world applications.

Prerequisite:
Digital Communication
Mobile Communication System

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction**	1.1 Introduction to 5G Technology, Features, Requirements, Applications, 5G Services, Introduction to 5Gi 1.2 Digital modulations (OFDM, 5G Technology Modulation Techniques) and performance metrics, 5G Internet, Internet of Things and Context-Awareness, Software Defined Networking, Network Function Virtualisation (NFV)	4	CO1
II	**5G Architecture**	2.1 5G Network Architecture, Cloud RAN(C-RAN), Definitions of Heterogeneous Networks, Radio Resource and Interference Management for Heterogeneous Networks, Traffic offloading scenarios for heterogeneous networks, mobility management and Handover 2.2 Small cell deployments: different types, Deployment scenarios, performance and analysis, Energy efficient mechanism with BS sleep mode in green small cell networks, Game theory and learning techniques for self-organization in small cell networks, 3GPP RAN standards for small cell	8	CO2
III	**Mm Wave**	3.1 mmWave: Millimeter bands, radio-wave propagation Physical layer design and algorithms, mmWave MIMO challenges, channel modelling, channel estimation and Beam-forming. Types of transceivers, Merits and Demerits, Applications	8	CO3

		3.2 Physical or Radio layer Technologies - Massive MIMO (Sub 6Ghz) -mm wave MIMO (above 6 GHz)		
IV	**NOMA**	Non orthogonal Multiple Access (NOMA), Different Types: power domain NOMA and code domain NOMA, Difference between Orthogonal multiple access and NOMA, Filter Bank multi carrier -Full duplex Radio Techniques, Precoding	5	CO4
V	**Cognitive Radio for 5G Wireless Networks**	5.1 Introduction, Overview of Cognitive Radio Technology in 5G Wireless, Spectrum Optimisation using Cognitive Radio, Cognitive Radio and Carrier Aggregation, Energy-Efficient Cognitive Radio Technology 5.2 Cognitive Radios to Mitigate Interference in Macro/femto Heterogeneous Networks, Cognitive Radio enabled Operations, Interference Coordination: Orthogonality in the Time/Frequency domain, Intra-tier Interference mitigation, Compressive sensing	8	CO5
VI	**Trends in 5G**	5G NR, Carrier Aggregation in 5G, Open RAN, Use cases of 5G:eMBB, URLLC and mMTC, Advance applications: Robotic surgery, driverless car and Industrial IoT (IIoT), Tactile Internet, 5G-IoT applications, AR/VR in 5G **Self-learning Topics:** 6G Wireless Communication: Vision, Enabling Technologies, and Challenges	6	CO6

Text Books:

1. Principles of Modern Wireless communication systems by Aditya k Jagannathan
2. Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport, Murdock, "Millimeter Wave Wireless Communication", Prentice Hall, 2014.

References:

1. R. Vannithamby and S. Talwar, Towards 5G: Applications, Requirements and Candidate Technologies., John Willey & Sons, West Sussex, 2017.
2. Manish, M., Devendra, G., Pattanayak, P., Ha, N., 5G and Beyond Wireless Systems PHY Layer Perspective, Series in Wireless Technology Springer, 2021
3. Alagan Anpalagan, Mehdi Bennis, Rath Vannithamby, Design and deployment of small cell networks, Cambridge university press, 2015

4. Rose Qingyang Hu, Yi Qian**,** Heterogeneous Cellular Networks, John Wiley & Sons, Ltd., Publication, 2013
5. T. S. Rappaport, R. W. Heath Jr., R. C. Daniels, and J. M. Murdock, Millimeter Wave Wireless Communication., Pearson Education, 2015.
6. M. Vaezi, Z. Ding, and H. V. Poor, Multiple Access techniques for 5G Wireless Networks and Beyond., Springer Nature, Switzerland, 2019

Online References:

Sr. No.	**Website Name**
1.	https://www.qualcomm.com/invention/5g/what-is-5g
2.	https://www.keysight.com/us/en/assets/7018-03173/technical-overviews/Introduction-to-OFDM.pdf
3.	https://www.ericsson.com/en/reports-and-papers/white-papers/manufacturing-the-future-of-5g
4	https://spectrum.ieee.org/5g-ar-vr

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC743	Internet Communication Engineering	03	--	--	03	--	--	03

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC 743	Internet Communication Engineering	20	20	40	60	2.5	--	--	100

Rationale : The Internet Communication Engineering syllabus is structured to provide students with a comprehensive understanding of the principles, protocols, and technologies that power modern internet-based communication. Covering topics such as IP addressing, routing, TCP/IP, VoIP, and next-generation network architectures, the course equips learners to design, analyze, and secure efficient internet communication systems. With the growing reliance on global digital connectivity, this course is essential for careers in networking, cybersecurity, and cloud-based services.

Course Objectives:

1. To understand the fundamental concepts, architecture, and protocols of the Internet.
2. To explore the role of the application layer protocols such as DNS, DHCP, and remote login mechanisms.
3. To study various security mechanisms at different layers of the Internet architecture.
4. To learn multimedia data formats, compression standards, and streaming protocols used over IP networks.

5. To comprehend Quality of Service (QoS) mechanisms and their implementation in IP networks.
6. To examine emerging trends such as Software Defined Networking (SDN), network automation, and the Internet of Things (IoT).

Course Outcomes:

1. Explain the structure and working of the Internet, including TCP/IP protocol stack and network services.
2. Apply application-layer protocols like DHCP, DNS, TELNET, and SSH for network services and communication.
3. Analyze and evaluate security techniques across network, transport, and application layers.
4. Demonstrate knowledge of multimedia encoding, compression standards, and IP-based multimedia transport.
5. Assess and differentiate QoS models like IntServ and DiffServ for traffic management in IP networks.
6. Illustrate the working of SDN, network automation concepts, and IoT architecture and protocols.

Prerequisite:
Analog Communication
Digital Communication
Computer Communication and Network

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to Internet**	What is the Internet, Evolution of the Internet, service description, Network protocol? Overview of TCP/IP, layer functions	3	CO1
II	**Application Layer in the Internet**	Application Layer- Host configuration, DHCP, Domain Name System (DNS), Multicast DNS Remote Login, TELNET and SSH, HTTPS, electronic mail	6	CO2
III	**Internet Security**	Network layer security (AH, ESP, IPsec) Transport layer security (SSL), Application layer security (secure E mail- PGP, S/MIME) VPN, Firewall, Intrusion Detection System.	5	CO3

IV	**Multimedia Communications**	Information Representation- text, images, audio and video, Text and image compression, Audio and video compression, video compression standards: H.261, H.263, P1.323, MPEG 1, MPEG 2, Other coding formats for text, speech, image and video multimedia transport across IP networks and relevant protocols such as RSVP, RTP, RTCP, DVMRP, Signalling Protocols: Real-Time Streaming Protocol (RTSP). VoIP, IPTV	10	CO4
V	**Quality of Services (QoS)**	Integrated services (intserv): Architecture and Service Model, Resource Reservation Protocol (RSVP), Packet Scheduling Disciplines in the Internet Differentiated Services (diffserv): Framework and Concept, Assured and Expedited Services, Packet Classification, Routers Internals and Packet Dropping Techniques	7	CO5
VI	**Trends in 5G**	Introduction to software defined networking, OPENFLOW,Why network automation? Simplified Architectures, Deterministic outcomes, Business Agility, Types of network automation, Device Provisioning, Data collection, Migrations, Configuration Management, Compliance, Reporting, Troubleshooting, Evolving from the management plane from SNMP to device APIs--- Impact of open networking, Network Automation in the SDN era.Introduction to Internet of Things (IoT): Definition and characteristics of IoT, Physical design of IoT: Things in IoT, IoT Protocols.	8	CO6

Text Books:

1. B. Forouzan, —*TCP/IP Protocol Suite*‖, 4th Edition, McGraw-Hill Publication
2. K. R. Rao, Zaron S. Bojkovic, Dragorad A. Milocanovic, Multimedia Communication Systems, Prentice Hall India, 2002. ISBN: 81-203-2145-6.
3. Network Programmability & Automation---Jason Edelman, Scott S. Lowe & Matt Oswalt, OREILLY.

References:

1. Steve Heath, Multimedia and Communication Technology, Second Edition, Focal Press, 2003.
2. ISBN: 81-8147-145-8. Ted Wallingford, ―*Switching to VoIP*‖, Oreilly Publication
3. Fred Halsall, ―Multimedia Communications‖, Pearson education, 2001
4. K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, ―Multimedia Communication Systems‖, Pearson education, 2004
5. Raif steinmetz, Klara Nahrstedt, ―Multimedia: Computing, Communications and Applications‖, Pearson education, 2002
6. Tay Vaughan, ―Multimedia: Making it Work‖, 6th edition, Tata McGraw Hill, 2004
7. Pallapa Venkataram, ―Multimedia information systems‖, Pearson education (InPress),2005.
8. Multimedia Communication Techniques and Standards
9. Arshdeep Bagha, Vijay Madisetti “Internet of Things”, universities Press.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC 744	Advanced Digital Signal Processing	03	--	--	03	--	--	03

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC 744	Advanced Digital Signal Processing	20	20	40	60	2.5	--	--	100

Rationale : The Advanced Digital Signal Processing syllabus is designed to deepen students' understanding of complex signal analysis and processing techniques beyond the basics, covering areas such as multirate processing, adaptive filtering, spectral estimation, and DSP architectures. As high-performance signal processing is critical in applications like biomedical engineering, communications, radar, and multimedia, this course equips learners with both theoretical knowledge and hands-on experience for solving real-world signal challenges using advanced algorithms and tools.

Course Objectives:

1. To understand the fundamentals of power spectrum estimation using both parametric and non-parametric methods.
2. To impart knowledge of optimum linear filtering techniques including Wiener filters and their applications.
3. To familiarize students with linear prediction theory and algorithms like Levinson-Durbin and Schur.
4. To explore the principles and applications of adaptive filters and adaptive filtering algorithms.
5. To introduce concepts of multi-rate signal processing including interpolation, decimation, and filter banks.

6. To provide insights into wavelet transform theory, multi-resolution analysis, and signal denoising techniques.

Course Outcomes:

1. Apply and analyze non-parametric and parametric methods for power spectrum estimation in signal processing applications.
2. Design and evaluate FIR and IIR Wiener filters for optimal signal estimation and noise reduction.
3. Implement linear prediction algorithms and apply them to signal modeling and estimation problems.
4. Develop and analyze adaptive filtering systems using algorithms like LMS, RLS, and their variants for real-time applications.
5. Analyze and implement multirate signal processing techniques such as decimation, interpolation, and polyphase structures.
6. Utilize wavelet transform techniques for multi-resolution signal analysis and perform signal denoising using thresholding methods.

Prerequisite:
Discrete Time Signal Processing

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Power Spectrum Estimation**	Principle of Power Spectrum Estimation Non Parametric Method of Power Spectrum Estimation: Modified Periodogram, Bartlett's Method, Welch's Method, Blackman-Tukey Method Parametric Methods for Power Spectrum Estimation: Relationships between the Autocorrelation and the Model Parameters, AR, MA & ARMA Models Introduction to Least-Squares Method for the AR Model Parameters and Yule-Walker Method for the AR Model Parameters	9	CO1
II	**Optimum Linear Filters**	Wiener Filters, FIR Wiener Filter (Wiener-Hopf filter) IIR Wiener filter (Non-Causal and Causal IIR Wiener Filter) Orthogonality Principle in Linear Mean-Square Estimation	3	CO2

III	**Linear Prediction**	Forward and Backward Linear Prediction Solution of Normal Equation (Levinson-Durbin and Schur Algorithm) ,AR Lattice and ARMA Lattice Ladder Filters MMSE Estimation, Introduction to Kalman Filter, Matched Filter	5	CO3
IV	**Adaptive Filters**	Adaptive Algorithms: LMS Algorithm, NLMS Algorithm, RLS Algorithm, Lattice Ladder Algorithm, Applications of Adaptive Filters: System Identification, Adaptive Channel, Equalization, Echo Cancellation, Adaptive Noise Cancellation **Self-Study:** Suppression of Narrowband Interference in Wideband Signals, Adaptive Array	7	CO4
V	**Multi-rate Signal Processing**	Introduction to Multi-rate Signal Processing Interpolation and Decimation, Sampling Rate Conversion by Non-integer Factor, Multistage Interpolation and Decimation , Polyphase Decomposition, Filter Banks: Quadrature Mirror Filter Banks **Self-Study:** Subband Coding	8	CO5
VI	**Trends in 5G**	Limitations of Fourier Transform and Short Time Fourier Transform, Introduction to Time-Frequency Tiling, Multi-resolution analysis using Discrete Time Wavelet Transform: Haar MRA, Analysis of two band dyadic filter banks, Frequency response of the Haar Filter Bank, Introduction to Daubechies Wavelets, Application of Wavelet theory to Signal Denoising (Soft and Hard Thresholding) **Self-Study:** Signal Compression, Image Compression	7	CO6

Textbooks:

1. John G. Proakis, Dimitris K. Manolakis, “Digital Signal Processing Principles, Algorithms, and Applications”, Prentice-Hall, 4th Edition, 2012.
2. Simon Haykin, “Adaptive Filter Theory”, Pearson Education, Fourth Edition, 2002.
3. Martin Vetterli, Jelena Kovacevic, “Wavelets and Subband Coding”, Prentice-Hall, 1995.

4. Burrus, C. Sidney, Ramesh A. Gopinath, and Haitao Guo, "Introduction to wavelets and wavelet transforms", Prentice Hall Inc. 1997"

Reference Books:

1. Emmanuel C. Ifeachor, Barrie W. Jervis, “Digital Signal Processing: A Practical Approach”, Pearson Education, 2008.
2. E. Chandrasekhar, V. P. Dimri, V. M. Gadre (Eds.), “Wavelets and Fractals in Earth System Sciences”, CRC Press, 2013.
3. Tarun Kumar Rawat, “Digital Signal Processing”, Oxford University Press, 2014.
4. K. Deergha Rao, M.N.S. Swamy, “Digital Signal Processing: Theory and Practice”, Springer, 2018.
5. K. P. Soman, K.I. Ramchandran and N. G. Reshmi, “Insight into Wavelets: From Theory to Practice", Third Edition PHI, 2010.
6. P. P. Vaidyanathan, “Multirate Systems and Filter Banks”, Prentice-Hall, 1993.
7. Sanjit K. Mitra, “Digital Signal Processing: A Computer-Based Approach”, McGraw Hill, 2011.

NPTEL / Swayam Course:

1. “Estimation of Signals and Systems” by Prof. S. Mukhopadhyay, IIT Kharagpur. https://nptel.ac.in/courses/108/105/108105059/
2. “Adv. Digital Signal Processing - Multirate and wavelets” by Prof. V. M. Gadre, IIT Bombay. https://nptel.ac.in/courses/117/101/117101001/

R-2025- B.E Electronics and Telecommunication Engineering

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut.	Total
ETC 745	Quantum Computing	03	--	--	03	--	--	03

		Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term work	Pract / Oral	Total
		Internal Assessment			End Sem. Exam.				
		IAT 1	IAT 2	Total					
ETC 745	Quantum Computing	20	20	40	60	2.5	--	--	100

Rationale: The Quantum Computing syllabus introduces students to the foundational principles of quantum mechanics applied to computation, including qubits, superposition, entanglement, and quantum gates. As classical computing approaches physical limits, this course prepares learners to explore next-generation problem-solving techniques with applications in cryptography, optimization, and machine learning. It equips students with both theoretical understanding and practical exposure to quantum algorithms and platforms like Qiskit or IBM Quantum Experience.

Course Objectives: The course aims:
1. To understand basics of quantum computing
2. To understand mathematics required for quantum computing.
3. To understand the building blocks of quantum computing.
4. To understand quantum algorithms.
5. To understand quantum hardware principles.
6. To understand tools for quantum computing.

Course Outcome:
After successful completion of the course student will be able to :-
1. Explain basic concepts of quantum computing
2. Explain mathematical fundamentals required for quantum computing.

3. Explain building blocks of quantum computing through architecture and programming models.
4. Explain quantum algorithms.
5. Explain quantum hardware building principles.
6. Explain usage of tools for quantum computing.

Prerequisite:
Digital System Design
Engineering Mathematics-III
Data Structures and Algorithm, Python Programming

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to Quantum Computing**	Motivation for studying Quantum Computing, Origin of Quantum Computing, Quantum Computer vs. Classical Computer, Introduction to Quantum mechanics, Overview of major concepts in Quantum Computing ,Qubits and multi-qubits states Bloch Sphere representation, Quantum Superposition ,Quantum Entanglement, Major players in the industry (IBM, Microsoft, Rigetti, D-Wave etc.)	7	CO1
II	**Mathematical Foundations for Quantum Computing**	Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert, spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors.	5	CO2
III	**Building Blocks for Quantum Program**	Architecture of a Quantum Computing platform,Details of q-bit system of information representation:Block Sphere, Multi-qubits States Quantum superposition of qubits (valid and invalid superposition),Quantum Entanglement Useful states from quantum algorithmic perceptive e.g. Bell State ,Operation on qubits:	8	CO3

		Measuring and transforming using gates. Quantum Logic gates and Circuit,No Cloning Theorem and Teleportation Programming model for a Quantum Computing Program , Steps performed on classical computer,Steps performed on Quantum Computer Moving data between bits and qubits.		
IV	**Quantum Algorithms and Error correction**	Quantum Algorithms, Shor's ,Algorithm, Grover's Algorithm, Deutsch's Algorithm Deutsch -Jozsa Algorithm, Quantum error correction using repetition codes 3 qubit codes, Shor's 9 qubit error correction Code	6	CO4
V	**Quantum Hardware**	Ion Trap Qubits,The DiVincenzo Criteria, Lagrangian and Hamiltonian Dynamics in a Nutshell: Dynamics of a Translating Rotor, Quantum Mechanics of a Free Rotor: A Poor Person's Atomic , Model: Rotor Dynamics and the Hadamard Gate, Two-Qubit Gates The Cirac-Zoller Mechanism: Quantum Theory of Simple Harmonic Motion, A Phonon-cubit Pair Hamiltonian, Light-Induced Rotor-Phonon Interactions, Trapped Ion Qubits, Mølmer-Sørenson Coupling .. Cavity Quantum Electrodynamics (cQED): Eigenstates of the Jaynes-Cummings Hamiltonian Circuit QED (cirQED): Quantum LC Circuits, Artificial Atoms, Superconducting Qubits Quantum computing with spins: Quantum inverter realized with two exchange coupled spins in quantum dots, A 2-qubit spintronic universal quantum gate.	10	CO5
VI	**OSS Toolkits for**	IBM quantum experience, Microsoft Q, Rigetti PyQuil (QPU/QVM)	3	CO6

	implementing Quantum program			

Text books:

1. Michael A. Nielsen, "Quantum Computation and Quantum Information", Cambridge University Press.
2. David McMahon, "Quantum Computing Explained", Wiley ,2008
3. Qiskit textbook https://qiskit.org/textbook-beta/
4. Vladimir Silva, Practical Quantum Computing for Developers,2018
5. Bernard Zygelman, A First Introduction to Quantum Computing and Information,2018
6. Supriyo Bandopadhyay and Marc Cahy, "Introduction to Spintronics", CRC Press, 2008.

Reference books

1. The Second Quantum Revolution: From Entanglement to Quantum Computing and Other Super-Technologies, Lars Jaeger

2. La Guardia**,** Giuliano Gladioli "Quantum Error correction codes"Springer,2021

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETL706	Microwave Engineering Laboratory	-	2	-	-	1	-	1

		Examination Scheme						
		Theory Marks				Term Work	Practical / Oral	Total
		Internal assessment			End Sem. Exam			
		IAT 1	IAT 2	Total				
ETL706	Microwave Engineering Laboratory	--	--	--	--	25	25	50

Lab Objectives:

1. To become familiar working with rectangular waveguides and doing microwave bench set up
2. To determine the characteristics of various microwave components
3. To be able to measure wave parameters like impedance, frequency, wavelength using microwave bench and VSWR/power meter
4. To study characteristics and behavior of various microwave semiconductor devices.

Lab Outcomes:

1. Able to handle microwave equipments
2. Able to understand microwave measurements and test the characteristics of microwave components
3. Able to understand Wave guide and transmission line measurements
4. Demonstrate working of microwave semiconductor devices
5. Demonstrate the microwave bench set up and conducting measurements of different parameters

DETAILED SYLLABUS:

Sr. No.	List of the Experiment	Hrs
1	Measurement of microwave frequency using direct and indirect method	2
2	Measurement of guide wavelength	2
3	Measurement of VSWR of unknown load	2
4	Measurement of impedance of unknown load.	2
5	Study of field patterns of various modes inside a rectangular waveguide cavity using Virtual lab	2
6	Study of field patterns of various modes inside a rectangular waveguide using Virtual lab	2
7	Find the change in characteristics impedance and reflection coefficients of the transmission line by changing the dielectric properties of materials Embedded between two conductors. using Virtual lab	2
8	Determination of VI characteristics of Gunn diode using microwave test bench.	2
9	Measurement of attenuation	2
10	Measurement of microwave power	2
11	Characterization of E plane TEE, H plane TEE and Magic TEE	2
12	Measurement of reflection coefficient using transmission line bench	2

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practicals' based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETL707	**Mobile Communication System Laboratory**	-	2	-	-	1	-	1

		Examination Scheme						
		Theory Marks				Term Work	Practical / Oral	Total
		Internal assessment			End Sem. Exam			
		IAT 1	IAT 2	Total				
ETL707	**Mobile Communication System Laboratory**	--	--	--	--	25	25	50

Lab Objectives:

1. To understand the inter-dependencies of design parameters of cellular system.
2. To examine orthogonality condition for CDMA systems.
3. To Classify different types of propagation models and analyze the link budget
4. To understand the working principles of OFDM, MIMO, and Cognitive radio.

Lab Outcomes:

1. Demonstrate the effect of cellular system design parameters on system capacity and quality of service.
2. Compare and contrast trunking radio systems.

3. Examine the effect of small-scale fading parameters on the performance of radio channel characteristics.
4. Analyze link budget for various propagation path-loss models.
5. Summarize the attributes of OFDM, MIMO, and Cognitive radio.
6. Evaluate the performance of different MIMO systems.

List of Experiments.

Sr No	List of Experiments	Hrs
01	To observe the effect of velocity and direction of arrival of a vehicle on Doppler frequency.	2
02	To observe the effect of Cluster size (N) on C/I ratio and comment on the voice quality.	2
03	To observe the effect of incidence angle on reflection coefficient.	2
04	To observe the effect of different propagation models on coverage distance.	2
05	To analyze the effect of delay on blocking probability of a call for Erlang B and Erlang C systems.	2
06	To observe the effect of C/I ratio in a sectorised cell site and perform worst case analysis for different values of N and degree of sectorisation A) Worst case C/I in a 3-sector cellular system for N = 7 B) Worst case C/I in a 3-sector cellular system for N = 4 C) Worst case C/I in a 6-sector cellular system for N = 7 D) Worst case C/I in a 6-sector cellular system for N = 4	2
07	To generate Pseudo noise code used in a CDMA system.	2
08	To generate Walsh Codes using Hadamard Matrix.	2
09	To plot Knife edge diffraction gain as a function of Fresnel diffraction parameter.	2
10	To analyze the effect of multipath diversity (RAKE receiver) on Bit Error Rate in CDMA system.	2

11	To plot channel capacity versus SNR for different MIMO systems.	2
12	Simulation of OFDMA system.	2
13	GSM Network simulation.	2
14	CDMA Network simulation.	2
15	Simulation of spectrum sensing using energy detection method in cognitive radio.	2
16	Demonstration of OFDM / MIMO /Cognitive radio.	2

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practicals' based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ETL708	Major Project-I	--	06	--	--	02	--	02

		Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam.			
		IAT 1	IAT 2	Total				
ETL708	Major Project-I	--	--	--	--	25	25	50

Rationale : The Major Project–I syllabus is designed to encourage students to apply theoretical knowledge and technical skills acquired during their course to solve real-world problems through practical implementation. It promotes innovation, teamwork, and project management skills by guiding students through the initial stages of research, design, and development under faculty supervision. This course lays the groundwork for Major Project and internship, fostering analytical thinking, creativity, and readiness for industry or higher research.

Course Objectives:

1. To acquaint yourself with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint yourself with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcomes:

1. Identify problems based on societal /research needs.

2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Major Project:

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do surveys and identify needs, which shall be converted into problem statements for projects in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plans in the form of Gantt/PERT/CPM charts, which will cover weekly activity of major project-I and major project-II.
- A log book to be prepared by each group, wherein the group can record weekly work progress, guide/supervisor can verify and record notes/comments.

- Faculty supervisors may give inputs to students during major project -I & Internship activity; however, focus shall be on self-learning.
- Students in a group shall understand problems effectively, propose multiple solution and select best possible solution in consultation with the guide/ supervisor.
- Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of institute.
- With the focus on self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Major Project, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Major Project-I in semester VII and continue in semester VIII.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Major Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to Scopus paper publications in Journal/Conference or Copyright or Patent as an extension of the Major

Project-1 with suitable improvements/modifications after testing and analysis in even semester. This policy can be adopted on a case by case basis.

Guidelines for Assessment of Major Project:

Term Work:

1) The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of major projects to be evaluated on a continuous basis, minimum two reviews in each semester VII and VIII.
2) In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
3) Distribution of Term work marks for both semesters shall be as below;
   a) Marks awarded by guide/supervisor based on log book: 10
   b) Marks awarded by review committee 10
   c) Quality of Project report 05

Review/progress monitoring committee may consider following points for assessment based on either one year major project as mentioned in general guidelines.

One-year project:

- In semester VII entire theoretical solution shall be ready, including components/system selection and cost analysis, building of working prototype. Two reviews will be conducted based on the presentation given by the student group.
  - First shall be for finalization of problem and proposed solution of the problem
  - Second shall be on readiness of working and testing of prototype to be conducted.
- In semester VIII expected work shall be procurement of testing and validation of results based on work completed in an odd semester.
  - First review is based on improvements in testing and validation results cum demonstration for publication to be conducted.
  - Second review shall be based on paper presentation in conference/journal or motivation for copyright or Indian patent in the last month of the said semester.

Assessment criteria of Major Project.

Major Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on the first six criteria and the remaining may be used for second semester evaluation of performance of students in the project.

Guidelines for Assessment of Major Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Major Projects shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Scopus Conferences/Journals or copy right or Indian Patent.

Major Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication
9. Publications in Sem VIII.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC 801	Optical Communication and Networks	03	--	--	03	--	--	03

		Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC801	Optical Communication and Networks	20	20	40	60	2.5	--	--	100

Rationale:

This syllabus is designed to provide students with a strong theoretical and practical foundation in optical fiber communication, a critical technology in modern high-speed data transmission and networking systems. As global demand for high-capacity, low-latency communication grows across industries such as telecommunications, defense, data centers, and healthcare, professionals must be equipped with the knowledge and skills to design, implement, and manage optical communication systems.

Course Objectives:

1. Introduction to optical fiber network: its need, elements and fundamentals.
2. To learn Parameters that limit the repeaterless transmission , its mitigation and Managing techniques.
3. To learn high speed optical sources, detectors and Amplifiers.
4. Study the multiplexing schemes SDH ,PDH and WDM and its applications for current and NGNs
5. To have an insight into optical packet switched, bust switched and advanced

networks

6. Learn high speed network management techniques and challenges in its counterpart Free Space Optics

Course Outcomes:

After successful completion of the course student will be able to:

1. Understand optical networks at large by identifying the types of fibers, cables and deployment.
2. Design point to point optical fiber communication links using appropriate optical fibers, light sources, couplers, detectors, and multiplexers.
3. Design a short haul or long-haul optical network with repeater by incorporating suitable amplifiers.
4. Compare SDH, PDH and WDM techniques and implement.
5. Explore concepts of designing and operating principles of modern optical communication systems and networks.
6. Apply the knowledge acquired to design the next generation fiber and FSO networks for indoor and outdoor applications

Prerequisite:

Engineering Physics-I
Engineering Physics-II
Electronic Devices & Circuits
Principles of Communication Engineering
Digital Communication
Electromagnetics and Antenna

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite**	Electromagnetic waves and light propagation (from Engineering Physics), Fundamentals of communication systems (modulation, bandwidth, signal transmission) ,Basic electronic devices (e.g., LEDs, photodiodes,	01	

		semiconductors),Introductory network architecture and protocols		
I	**Introduction and Basics of Optical fiber communication**	1.1 Historical Development, Electromagnetic Spectrum, Optical Bands and Windows, Need for optical fiber communication, Fiber optic cable types and color codes, Block diagram, advantages and disadvantages of optical fiber cables, loss and bandwidth, applications and deployment. 1.2 Basics of Optical Fiber: Review of Ray theory, Wave theory, Light propagation in optical fiber Classification of optical fibers, Propagation modes, MFD in SMF 1.3 Fiber material, Fabrication techniques for high quality fiber: MCVD, fiber joints, fiber connectors, splices. Brief introduction to Photonic Crystal Fiber and its types.	07	CO1
II	**Transmission Characteristic of Optical Fiber**	2.2 Dispersion in Optical fiber, types of dispersion, Dispersion compensation techniques and dispersion measurements, Time domain and Frequency Domain measurements. Dispersion management, Need for dispersion management and Post compensation Techniques. 2.2 Transmission losses in the optical fiber, Attenuation, Absorption losses, radiation losses and linear scattering losses, Comparison of optical fibers, Measurement of attenuation: Insertion loss, Return loss, OTDR.	07	CO1
III	**Optical Communication Systems**	3.1 Working principle and characteristics of sources Edge emitting LED,, Edge emitting	07	CO2

		LASER, VCEL, Spectrum, Noise, and Optical amplifiers . 3.2 Working principle and characteristics of detectors (PIN, APD),coherent and non-coherent detection, Intensity modulated direct detection, optical receivers, receiver performance: Bit error rate, Q function and Eye diagram 3.3 Point to point links system considerations, link power budget, and rise time budget		
IV	**Optical Network System Components and Optical Networks**	4.1 Optical Network System Components and Optical Networks 4.2 SONET and SDH standards, architecture of optical transport networks (OTNs), protection schemes in SONET/SDH, PDH 4.3 Operational principle of WDM, WDM network elements and Architectures. Types of WDM Networks, WDM Access Network, WDM Metro Networks, WDM Long Haul Networks Data center networks and Elastic Networks	08	CO4
V	**Packet Switching and Access Networks**	5.1 OTDM, multiplexing and demultiplexing, synchronization and broadcast OTDM networks. 5.2 Network architecture overview, optical access networks. FTTH Network 5.3 Optical Burst switching Networks	04	CO5
VI	**Network Design and Management**	6.1Transmission system model, power penalty, transmitter, receiver, optical amplifiers, crosstalk. 6.2 Network management functions, configuration	06	CO3 & CO6

		management, performance management, fault management, optical safety, and service interface 6.3 Introduction to free space optics and its challenges		

Text books:

1. John M. Senior, ―Optical Fiber Communication‖, Prentice Hall of India Publication,
Chicago, 3rd Edition, 2013
2. Gerd Keiser, ―Optical Fiber Communication‖, Mc-Graw Hill Publication , Singapore,
4th Edition, 2012
3. T.L.Singhal –Optical Fiber Communication Principles and Applications, Cambridge
Press, Edition 2016
4. Kumar Sivarajan and Rajiv Ramaswamy, Morgan Kauffman, Optical Networks: A Practical Perspective, Elsevier Publication Elsevier India Pvt. Ltd, 3rd Edition, 2010.
5. Ivan B. Djordjevin,__Advanced Optical and Wireless Communication Systems,Springer,Edition 2018.
6. Debasish Datta,Optical Networks,Oxword Cambridge University Press,2021
7. Kaushal, H.Jain, V.K. Kar,S, Free Space Optical Communication ,Springer,2017

Reference books

1. G Agarwal, ―Fiber optic communication Systems‖, John Wiley and Sons, 3rd Edition,
New York 2014
2. Rajiv Ramaswami and Kumar N. Sivarajan, ―Optical Networks: A Practical Perespective‖, Elsevier Publication Elsevier India Pvt.ltd, 3rd Edition, 2010
3. P.E.Green, ―Optical Networks‖, Prentice Hall,1994
4. Biswanath Mukherjee, ―Optical Communication Networks‖, McGraw-Hill, 1997.
5. Le Nguyen Binh, ―Optical Fiber Communication System: Theory and Practice with
MATLAB and Simulink‖, CRC Press, 2010
6. 2. Harry G. Parros, Communication Oriented Networks, Wiley
7. G. Agrwal, Fiber Optic Communication Systems, John Wiley and Sons, 3rd Edition,
New York, 2014.

Online References:

Sr. No.	Website Name
1.	https://www.iitg.ac.in/psm/qip2015/material/Subir_Bandyopadhyay_Lecture1.pdf
2.	https://www.rp-photonics.com/fiber_fabrication.html
3.	www.osa.org

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Course Code	Course Name	Teaching Scheme (Contact Hrs.)			Credits Assigned			
		Theory	Pract .	Tut.	Theory	Pract.	Tut.	Total
ETC821	System on Chip Design	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Pract./ Oral	Total
		Internal assessment			End Sem. Exam				
		IAT 1	IAT 2	Total					
ETC 821	System on Chip Design	20	20	40	60	2.5	--	--	100

Rationale: The System on Chip (SoC) Design syllabus is crafted to provide students with an in-depth understanding of integrating multiple components—processors, memory, interfaces, and custom logic—onto a single chip. As SoCs power everything from smartphones to embedded and IoT devices, this course emphasizes architecture, hardware-software co-design, and verification techniques essential for building high-performance, low-power, and cost-effective integrated systems.

Course Objectives:

1. **To introduce** the basic concepts, challenges, and economics associated with System on Chip (SoC) design.
2. **To explain** the architecture and design methodologies for complex SoC systems, including communication and computation balancing.
3. **To provide knowledge** on RTL design using Verilog with an emphasis on synthesis, FSM design, and memory modeling.
4. **To familiarize students** with SoC verification techniques including block-level and system-level verification approaches.
5. **To develop understanding** of physical design processes such as floor planning, placement, routing, and verification.
6. **To demonstrate** reconfigurable SoC arithmetic design using FPGA and LUT-based implementation through case studies.

Course Outcomes :

1. Describe the SoC design flow, semiconductor economics, and key challenges in SoC development.
2. Analyze and design processor-centric SoC architectures, interconnects, and integrate hardware/software components effectively.
3. Apply Verilog for RTL design and synthesis, following industry-standard coding guidelines for FSMs and memory models.
4. Implement SoC verification methods at both system and block levels, including timing verification techniques.
5. Execute the physical design process of SoC, including partitioning, floor planning, placement, and routing.
6. Design and simulate arithmetic blocks like adders and multipliers using LUTs on FPGA for reconfigurable SoC applications.

Pre-requisites:

Digital Logic Design
Computer Architecture

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to SoC Design**	The fundamental trends of SoC design, SoC design flow, The Semiconductor Economics, Challenges in SoC design, Hardware system structure, Software structure, Accelerating Processors for traditional software task, System Design with multiple processor design.	07	CO1
II	**System Level Design**	Complex SoC system architecture, Processor centric SoC organization, Communication Design – Hardware and Software interconnects, Balancing computation and Communication, SoC Design flow, Non-processor, building block in SoC design.	05	CO2
III	**RTL Synthesis**	Review of Verilog - RTL Coding and RTL Synthesis RTL coding guidelines,	08	CO3

		Synthesizable coding style, FSM Coding style, Memory Modelling		
IV	**SoC Verification**	Verification technology options, Verification methodology. System level, verification, block-level verification. Timing verification.	08	CO4
V	**Physical Design**	Partitioning, Floor Planning, Placement, Routing, Goals of routing, Global routing, Physical verification and design sign-off	06	CO5
VI	**Reconfigurable SoC Arithmetic: Case Study**	16 bit Carry Skip Adder on FPGA using LUT, 16 bit Carry Select Adder on FPGA using LUT, Divide-and-conquer 4 × 4 multiplier design using LUT	04	CO6

Textbooks:

1. Engineering the Complex SOC: Fast, Flexible Design with Configurable Processors-Chris Rowen, Pesrson, 2004.
2. System on a chip verification: Methodology and Verification-Second edition, Prakash Rashinkar, Peter Paterson, Leena Singh, Kluwer Academic Publishers
3. Digital Design with RTL Design, VHDL and VERILOG- Frank Vahid, John Wiley and Sons Publisher, 2010

Reference Books:

1. System-on-a-Chip: Design and Test- Rochit Rajsuman-Artech house-2002
2. VLSI Physical design Automation: Theory and Practice, Sadiq Sait, Habib Youssef, World Scientific Publishing, 1999
3. Surviving the SoC revolution- Henry Chang, Larry Cooke, Grant Martin, Kluwer Academic Publishers-2002

E-Resources:

1. https://nptel.ac.in/content/storage2/courses/117101058/downloads/Lec-2.pdf

2. https://www.btechguru.com/engineering-videos--electrical-engineering--circuit-theory--system-on-chip-(soc)-video-lecture--1790--4--21.html

3. http://www.asic.co.in/DesignGuidlinesRTLcoding.htm#:~:text=1.1%20STYLE%20AND%20NAMING%20GUIDELINES&text=WHY%3A%20Readability%20is%20required%20to,well%20as%20transferability%20between%20designers.&text=WHY%3A%20To%20avoid%20conflict%2C%20module,%E2%80%9Ccontrol%E2%80%9D%20are%20too%20generic

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Course Code	Course Name	Teaching Scheme (Contact Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETC 822	Natural Language Processing	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Pract./ Oral	Total
		Internal assessment			End Sem. Exam				
		IAT 1	IAT 2	Total					
ETC 822	Natural Language Processing	20	20	40	60	2.5	--	--	100

Rationale: The Natural Language Processing syllabus is designed to introduce students to the computational techniques for analyzing, understanding, and generating human language. With applications in machine translation, chatbots, sentiment analysis, and information retrieval, this course equips learners with the foundational algorithms, linguistic concepts, and deep learning approaches used in modern NLP systems.

Course Objectives:

1. **To introduce** the fundamental concepts, components, and levels of Natural Language Processing systems.
2. **To build** mathematical and linguistic foundations necessary for probabilistic language modeling and grammar understanding.
3. **To develop** understanding of word-level analysis including tokenization, stemming, and morphological processing.
4. **To study** syntax analysis using POS tagging and statistical models such as Hidden Markov Models and Viterbi Algorithm.
5. **To explore** semantic analysis and word sense disambiguation using lexical databases like WordNet.

6. **To provide insights** into discourse-level processing and real-world applications of NLP like machine translation and sentiment analysis.

Course Outcomes :

1. Describe the architecture, design stages, and challenges in building NLP systems.
2. Apply probability theory and grammar rules to support language modeling and parsing.
3. Perform word-level text processing including tokenization, lemmatization, and morphological analysis.
4. Implement syntax analysis using POS tagging and probabilistic models such as HMMs.
5. Analyze semantic relationships and perform word sense disambiguation using tools like WordNet.
6. Apply NLP techniques in real-world tasks such as sentiment analysis, text summarization, and information retrieval.

Prerequisites:

Discrete Mathematics
Artificial Neural Network and Fuzzy Logic
Data Structures and Algorithms

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to Natural Language Processing**	The need of NLP. Generic NLP system, Levels of NLP,Stages in building a Natural Language Processing System. Challenges and ambiguities in NLP Design	06	CO1
II	**Mathematical and Linguistic Preliminaries**	Probability Theory, Conditional Probability and Independence, Bayes Rule, Random Variables, Probability Distributions, Statistics, Counting, Frequency, Mean and Variance English Grammar, Parts of Speech, Phrase Structures	06	CO2
III	**Word Level Analysis**	Tokenization, Segmentation, Lemmatization, Edit Distance, Collocations, Porter Stemmer, N-gram Language Model, Morphological	06	CO3

		Analysis, Derivational and Reflectional Morphology		
IV	**Syntax-Analysis**	Tag set for English, Penn Tree bank, Introduction to Parts of Speech Tagging (POST), Markov Processes, Hidden Markov Models (HMM), Parts of Speech Tagging using Hidden Markov Models, Viterbi Algorithm	08	CO4
V	**Semantic Analysis**	Lexical Semantics, ambiguous words, word senses, Relations between senses: synonym, antonym, reversives, hyponym, hypernym, meronym, structured polysemy, metonymy, zeugma, Introduction to WordNet, gloss, synset, sense relations in WordNet. Cosine distance between documents. Word sense disambiguation.	08	CO5
VI	**Pragmatics and applications of NLP**	Reference resolution: Discourse model, Reference Phenomenon, Syntactic and Semantic Constraints on co reference, Applications of NLP: Categorization, Summarization, Sentiment Analysis, Named Entity Recognition, Machine Translation, Information Retrieval, Question Answer System	05	CO6

Text Books:

1. Daniel Jurafsky, James H. Martin, Speech and Language Processing‖ Second Edition, Prentice Hall.
2. Christopher D. Manning and Hinrich Schutze, Foundations of Statistical Natural Language Processing, MIT Press.

Reference books

1. Steven Bird, Ewan Klein, Natural Language Processing with Python, O'Reilly

2. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor), The Handbook of Computational Linguistics and Natural Language Processing

NPTEL / Swayam Course:

1. Course: Natural Language Processing By Prof. Pawan Goyal, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc21_cs102/preview
2. Course: Applied Natural Language Processing By Prof. Ramaseshan R, CMI https://onlinecourses.nptel.ac.in/noc20_cs87/preview

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC823	Wireless Networks	03	--	--	03	--	--	03

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC 823	Wireless Networks	20	20	40	60	2.5	--	--	100

Rationale : The Wireless Networks syllabus is designed to provide students with a comprehensive understanding of wireless communication principles, protocols, standards, and technologies such as Wi-Fi, Bluetooth, 4G/5G, and sensor networks. As wireless connectivity becomes the backbone of modern communication systems, this course prepares learners to design, analyze, and implement secure and efficient wireless network solutions for applications in mobile computing, IoT, and smart infrastructure.

Course Objectives:

1. To analyze the fundamental architecture, design issues and standards of wireless networks.
2. To compare Personal Area Network (PAN) technologies such as ZigBee, Bluetooth, UWB, NFC and 6LoWPAN.
3. To classify different LAN topologies and technologies and ad hoc networks.
4. To classify network protocols, ad hoc vehicle networks and Wireless MANs.
5. To understand planning and design of GSM and CDMA system in Wireless WANs.To apply Wireless sensor networks concepts to develop an IoT applications.
6. To apply Wireless sensor networks concepts to develop an IoT applications.

Course Outcomes:

1. Explain fundamental architecture, design issues and standards of wireless networks.
2. Compare different types of Personal Area Network (PAN) technologies such as ZigBee, Bluetooth, UWB, NFC and 6LoWPAN.
3. Analyze different LAN topologies and technologies and ad hoc networks.
4. Compare various types of network protocols, ad hoc vehicle networks and Wireless MANs.
5. Evaluate the planning and design of performance of GSM and CDMA system in Wireless WANs.
6. Understand the basic network architecture of Wireless sensor networks concepts to develop an IoT applications.

Prerequisite:

Computer Communication and Networks
Mobile Communication System

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Overview of wireless networks**	**1.1 Wireless Networks**: Architecture, Classifications, Switching technology, Communication Problems, Reference Models. Networking issues and Networking Standard. 1.2 **Wireless Body Area Networks:** Properties, Network Architecture, Network components and Applications	4	CO1
II	**Wireless Personal Area Networks**	**2.1 WPAN:** Bluetooth (802.15.1): Radio Specifications, Protocol Stack, Link Types, Security, Topologies, Applications. **2.2 ZigBee (802.15.4):** Radio Specifications, Components, Topologies, Protocol Stack, Applications. **2.3 RFID:** Radio Specifications, Architecture, Types and applications. **2.4 Near Field Communication & UWB (802.15.3 a):** Introduction and working. **2.5 6LoWPAN:** Features, Architecture, protocol stack and applications	10	CO2

III	**Wireless Local Area Network & Wireless Adhoc Networks**	**3.1 Wireless Local Area Network:** Equipment, Topologies, Technologies, Applications, Main features of IEEE802.11a,b, i and n, Protocol Architecture of WLAN 3.2 **Wireless Adhoc Networks**: Features, advantages & Applications **Mobile Adhoc Networks:** Network Architecture, MAC Protocol.	6	CO3
IV	**Wireless Metropolitan & Vehicular Adhoc Networks**	4.1 **WMAN(IEEE802.16):**Introduction, WMAN Network Architecture, Network Protocols, Broadband Wireless Networks, Applications 4.2 **Vehicular Adhoc Networks (VANETs):** Characteristics, Protocols & Applications	5	CO4
V	**Wireless Wide Area Networks**	5.1 Planning and design of Wireless Networks, Radio design for a cellular Network 5.2 Receiver sensitivity, Link budget for GSM and CDMA Systems, HSDPA	6	CO5
VI	**Advanced Technologies of Wireless Networks**	**6.1Wireless Sensor Networks:** Network Architecture, Design Considerations, Network Protocol Stack, and Applications 6.2**Wireless Mesh Network:** Network architecture, Protocols, technologies, Applications **Self-learning Topics:** Security and Privacy in Next-Generation Wireless Networks (5G and Beyond)	8	CO6

Text Books and References:

1. Vijay K. Garg, "Wireless Communication and Networking", Morgan -Kaufmann Series in Networking—Elsevier
2. Kazem Sohraby, Daniel Minoli, and Taieb Znati, "Wireless Sensor Networks: Technology, Protocols, and Applications", Wiley Student Edition
3. Dr SunilkumarS. Manvi, Mahabaleshwar S. Kakkasageri, "Wireless and Mobile Networks Concepts and Protocol"Wiley India Pvt Ltd
4.Raj Kamal, "Internet of Things Architecture & Design Principles" Mcgraw Hill

Online References:

Sr. No.	Website Name
1.	https://www.coursera.org/learn/wireless-communications

2.	https://nptel.ac.in/courses/117104099
3.	https://ocw.mit.edu/courses/6-450-principles-of-digital-communications-i-fall-2006/

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC824	**Web Design**	**3**	**-**	**-**	**3**	**-**	**-**	**3**

		Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC824	**Web Design**	20	20	40	60	2.5	--	--	100

Rationale : The Web Design syllabus is structured to equip students with the essential skills to design and develop user-friendly, responsive, and accessible websites using HTML, CSS, JavaScript, and modern frameworks. As web presence is crucial for businesses, services, and communication in the digital age, this course blends creativity with technical proficiency, enabling students to build interactive and visually appealing web applications aligned with industry standards.

Course Objectives:

1. To design and create web pages using HTML5 and CSS3.
2. To implement client-side scripting to static web pages.
3. To create dynamic web pages using server-side scripting.
4. To use MVC framework for web application development.
5. To use web services in web application development

Course Outcomes:

1. Design web pages using HTML5 and CSS3.
2. Apply the concepts of client-side validation and scripts to static web pages using JavaScript and its framework.
3. Build responsive web pages using front-end framework Bootstrap.
4. Develop a web application using appropriate web development framework.

5. Understand working of web services.

Prerequisite:

Skill development lab Java

Skill development lab Python

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	INTRODUCTION TO WWW	Understanding web system architecture, understanding 3 - tier web architecture. Clients, Servers and Communication, The Internet, Basic Internet protocols, World wide web, HTTP Request Message, HTTP Response Message, Web Clients, Web Servers	03	CO1
II	CLIENT SIDE PROGRAMMING PART I	HTML: Basic structure of an HTML5 document, Creating an HTML5 document, Markup Tags, Heading-Paragraphs, line Breaks HTML5 Tags - Introduction to elements of HTML, Working with Text, Lists, Tables and Frames, Hyperlinks, Images and Multimedia, Forms and other HTML5 controls CSS: Concept of CSS, Creating Style Sheet, CSS Properties, CSS Styling 4 (Background, Text Format, Controlling Fonts), Working with block elements and objects, Lists and Tables, CSS Id and Class, Box Model(Introduction, Border properties, Padding Properties, Margin properties), CSS Advanced (Grouping, Dimension, Display, Positioning, Floating, Align, Pseudo class, Navigation Bar, Image Sprites, Attribute sector)	05	CO1
III	CLIENT SIDE PROGRAMMING PART II	Bootstrap Introduction to Bootstrap, downloading and installing Bootstrap. The Grid System: Introducing the Grid, Offsetting and Nesting, Responsive Features, Utility Classes, and Supported Devices. CSS Foundations: Typography in Bootstrap, Styling Tables, Styling Forms, Styling Buttons, Images, icons, and Thumbnails. Navigation Systems: Tabs, Pills, and Lists, Breadcrumbs and Pagination, Navigation Bar, Making the Navigation Bar Responsive	03	CO3

IV	WEB DEVELOPMENT WITH JAVA	Server-side programming Java Servlets: Java Servlet Architecture, Servlet Life Cycle, Form GET and POST actions, Session Handling, Understanding Cookies, Client-side programming: JavaScript Introduction to JavaScript, Lexical Structure, Types, Values, Variables, Expressions and Operators, Statements, Objects, Arrays, Functions, Pattern matching with regular expressions, JavaScript in Web Browsers, The Window object, Scripting Documents, Handling Events. Client-side programming: JavaScript framework jQuery jQuery: jQuery Basics, jQuery Getters and Setters, Altering Document Structure, Handling events with jQuery, Animated Effects, Utility functions, jQuery Selectors and Selection Methods,	12	CO2
V	SERVER SIDE PROGRAMMING	MVC architecture - Introduction and applications, Server side-scripting – Laravel Framework Managing Your Project Controllers, Layout, Views, and Other Assets. Introduction to PHP, PHP Tags, Adding Dynamic content, accessing form variables, identifiers, user-declared variables, Data types, Constants, Operators, Control structures, Conditionals, Iteration constructs, using arrays, string manipulation and regular expressions, reusing code and writing functions. Designing and creating your web database, Accessing MySQL database from the Web with PHP, Session Control in PHP Introduction to AJAX: AJAX design basics, AJAX vs Traditional Approach, Rich User Interface using Ajax.	12	CO4
VI	WEB SERVICES	Introduction to Web Services: The definition of web services, basic operational model of web services (SOAP and REST), tools and technologies enabling web services, benefits and challenges of using web services. Web Services Architecture: Web services Architecture and its characteristics, core building blocks of web services, standards and technologies available for implementing web services, web services communication, basic steps of implementing web services	03	CO5

Text Books:

1. "Web Technology Black Book", Dreamtech Press, First Edition, 978-7722- 97

2. WEB TECHNOLOGIES A Computer Science Perspective Jeffrey C. Jackson Duquesne University

3 Developing Java Web Services, R. Nagappan, R. Skoczylas, R.P. Sriganesh, Wiley India, rp 2008

4. Learning Bootstrap Aravind Shenoy Ulrich Sossou PACKT PUBLISHING

References:

1. Ralph Moseley, M.T. Savliya , “Developing Web Applications", Willy India, Second Edition,

2. Robin Nixon, "Learning PHP, MySQL, JavaScript, CSS & HTML5" Third Edition, O’REILLY,2014.

(http://www.ebooksbucket.com/uploads/itprogramming/javascript/Learning_PHP_MySQL

_Javascript_CSS_HTML5 Robin_Nixon_3e.pdf)

3. Professional Rich Internet Applications: AJAX and Beyond, Dana Moore, Raymond Budd, Edward Benson, Wiley publications. https://ebooks-it.org/0470082801-ebook.htm

4. Jennifer Kyrnin, “SAMS Teach Yourself Bootstrap in 24 hours”, 1st edition, Pearson Education.

5. Martin Bean, “Laravel 5 Essentials”, PACKT Publishing Ltd

6. Harvey & Paul Deitel & Associates, Harvey Deitel and Abbey Deitel, “Internet and World Wide Web - How To Program”, Fifth Edition, Pearson Education, 2011.

7. Achyut S Godbole and Atul Kahate, “Web Technologies”, Second Edition, Tata McGraw Hill, 2012.

8. Thomas A Powell, Fritz Schneider, “JavaScript: The Complete Reference”, Third Edition, Tata McGraw Hill, 2013.

9. David Flanagan, “JavaScript: The Definitive Guide, Sixth Edition”, O'Reilly Media, 2011

10. Steven Holzner, “The Complete Reference – PHP”, Tata McGraw Hill, 2008

11. Mike Mcgrath, “PHP & MySQL in easy Steps”, Tata McGraw Hill, 2012.

12. J. Millman and A. Grabel, “Head First HTML and CSS”, 2nd edition, O‟ Reilly..

13. Ben Frain, “Responsive Web design with HTML5 and CSS3”, PACKT Publishing Ltd.

14. L. Welling and L. Thomson, "PHP and MySQL Web Development", 4th edition, Adison Wesley Professional.Outline

Online References:

Sr. No.	Website Name
1.	www.w3schools.com

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC825	RF Design	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC825	RF Design	20	20	40	60	2.5	--	--	100

Rationale : The RF Design syllabus aims to provide students with a thorough understanding of radio frequency circuit principles, component modeling, and high-frequency behavior essential for modern communication systems. With the increasing demand for wireless technologies in 5G, IoT, and radar applications, this course prepares learners to design, simulate, and analyze RF systems including amplifiers, filters, and matching networks using both theoretical and software-based approaches.

Course Objectives:

1. To learn RF circuit fundamentals.
2. To learn designing of RF amplifier.
3. To learn designing of RF Oscillators.
4. To learn and differentiate designing of RF Mixers.
5. To learn importance of EMI and EMC.
6. To learn fundamentals of RF transceiver.

Course Outcomes:

1. Design Impedance matching networks and passive RF filters.
2. Design and appraise RF amplifiers.
3. Design and appraise RF Oscillators.
4. Differentiate RF mixers.
5. Analyze EMI and EMC in RF circuits.
6. Analyze the stability of RF trans-reciever

Prerequisite:

Electromagnetic Antenna

Microwave Engineering

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite			
I	**RF Filter Design**	Introduction to Periodic Structure, Filter design using Image parameter method (Theory and Numerical) , **Filter design using Insertion loss method-** Maximally flat low pass prototype, Equal ripple low pass prototype, Filter transformation and filter implementation. (Theory and Numerical). **Self-learning Topics:** Design of bandpass and bandstop filters using low-pass prototypes	8	CO1
II	**Microwave Amplifier Design**	Two-port power gain derivation, signal flow graph(SFG) and stability criterion(Theory and Numerical), **Single stage amplifier design**: Design for maximum gain, design for specified gain, low noise amplifier design (Theory and Numerical), **Power amplifier design**: Characteristics of power amplifier and classes of amplifiers, design of class A power amplifier. (Theory and Numerical). **Self-learning Topics:** Impedance matching techniques using Smith Chart	10	CO2
III	**Microwave Oscillator**	One-port microwave oscillator design. (Theory and Numerical), Two-port microwave oscillator design. (Theory and Numerical), Analysis of phase noise in oscillators.	06	CO3

		Self-learning Topics: Design of voltage-controlled oscillators (VCOs)		
IV	**Microwave Mixer**	**Mixers:** Characteristics, Various types of Mixers: Single ended diode mixers, FET mixers, Balanced mixers, Image reject mixers and other types of mixers. **Self-learning Topics:** Mixer performance metrics: Conversion loss, isolation, noise figure	05	CO4
V	**Electromagnetic Interference in RF circuits**	**Introduction**: Natural and Nuclear Sources of EMI, EMI From Apparatus and Circuits. Quantification of Communication System EMI, **Elements of Interference** Including Antennas, Transmitters, Receivers and Propagation. Electronic Equipment And System EMI Concepts. Examples Of EMI Coupling Modes, **Mode of coupling**: Common-Mode coupling , Differential mode coupling, and other coupling mechanisms (Power supply and victim amplifiers). **Self-learning Topics:** EMI simulation and prediction tools (e.g., CST Studio Suite)	04	CO5
VI	**Electromagnetic Compatibility**	**For Achieving EMC**: Grounding, Bonding, Shielding Effectiveness, EMI Diagnostics And Fixes: Techniques Used In EMI Diagnostics Fixes, troubleshooting. **Instruments, Tools, used to measure Electromagnetic Field (Radiated and Conducted Emission)**: voltage and current probe, LISN, CDN, Clamp, Field probes, Spectrum analyzer, Oscilloscope, EMI Receiver, **Electromagnetic Noise specification**: Surge, EFT (Electrical Fast transients), PFMF, Radiated and conducted susceptibility, Voltage and dips interruption, Ring wave, Damped oscillatory wave, **EMC Specifications, Standards And Measurements**: A Discussion of the Genesis of	06	CO6

		EMC documentation including a historical Summary, The Rationale, and A Review of MIL-Std., FCC And CISPR Requirements. **Self-learning Topics:** EMC considerations in automotive and aerospace electronics. EMC in medical devices and wireless communication systems		

Text Books:

1. David Pozar, "Microwave Engineering", Wiley Publication (Fourth Edition)
2. Ludwig R. and Bogdanov G., "RF Circuit Design", Prentice Hall
3. Jack Smith, "Modern Communication circuits", Tata McGraw Hill
4. W. Prasad Kodali, "Engineering Electromagnetic Compatibility: Principles, Measurements, Technologies, and Computer Models", Wiley-IEEE Press (Second Edition)
5. David. A. Weston, "Electromagnetic Compatibility principles and applications", Marcel Dekker (Second Edition)
6. MARK I. MONTROSE EDWARD M. NAKAUCHI, "Testing for EMC compliance: Approaches and Techniques"

Reference books

1. Guillermo Gonzalez, "Microwave Transistor Amplifiers Analysis and Design "Prentice Hall. (Second Edition)
2. M. L. Sisodia, G. S. Raghuvanshi, " Microwave Circuits and Passive Devices", New Edge International Publisher(First Edition)
3. Clayton R. Paul, "Electromagnetic Compatibility", John Wiley & Sons. (Second Edition)

Useful Links:

1. www.nptelvideos.in
2. https://nptel.ac.in/courses/108/106/108106138/
3. https://freevideolectures.com/course/4367/nptel-microwave-theory-techniques

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC831	**Autonomous Vehicles**	**3**	**-**	**-**	**3**	**-**	**-**	**3**

		Examination Scheme					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC 831	**Autonomous Vehicles**	20	20	40	60	2.5	--	--	100

Rationale:

The Autonomous Vehicles syllabus is designed to introduce students to the interdisciplinary technologies behind self-driving systems, including perception, decision-making, control algorithms, and sensor fusion. With the rapid advancements in AI, robotics, and vehicular communication, this course equips learners to develop and analyze intelligent transportation systems that ensure safety, efficiency, and autonomy in modern mobility solutions.

Course Objectives:

1. Introduction to Autonomous vehicles/SDC (Self Driving Cars), advantages and challenges in SDC's
2. Gain Knowledge about the Sensors in SDC's
3. Understand the in-vehicle communication aspect in SDC's
4. Understand perception and localization in SDC's
5. Get to grips with planning and control in SDC's
6. To know the various applicatinos of SDC's

Course Outcomes:

After successful completion of the course students will be able to

1. Understand fundamentals of SDC's
2. Compare difference types of Sensors in SDC's
3. Illustrate different protocols of In-vehicle communication for SDC's
4. Identify perception and localization in SDC's
5. Analyse planning and control in SDC's

6. Evaluate different application and algorithms in SDC's

Prerequisite:

Knowledge of Sensor Technology ,

IPMV,

Deep Learning

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction**	1.1 Introduction to Autonomous Vehicles /Self Driving cars (SDC), Benefits of SDCs, Challenges in Current Deployment. 1.2 Levels of Autonomy	4	CO1
II	**Sensors in Autonomous Vehicles**	2.1 Camera (3D and stereo), LiDAR, Sensor Fusion 2.2 Passive Perception with Sonar and Millimeter Wave Radar 2.3 Vehicle-to-Everything Infrastructure	6	CO2
III	**In-Vehicle Communication Systems**	3.1 CAN: Introduction and architecture 3.2 CANopen: Introduction and architecture 3.3 FlexRay protocol: Introduction and architecture 3.4 Introduction to Operating System for SDC's.	8	CO3
IV	**Perception and Localization in SDC**	4.1 Introduction to Computer vision in SDC. Artificial eyes VS human eyes. Four pillars of autonomous driving: Perception, Localization, Planning and Control. 4.2 Perception: Object Detection and Line Lane detection Object/ obstacle Detection: Comparison of 2D and 3D object detection. Overview of ML algorithms for obstacle detection-Histogram of Oriented Gradients (HOG), Support Vector Machine (SVM). Object detection using deep learning algorithm: Architecture of YOLO 4.3 Line Lane Detection: Introduction to Semantic Segmentation, architecture,	9	CO4

		overview of different semantic segmentation architecture. 4.4 Localization: Introduction to GNSS, GNSS error analysis, Visual Odometry, SLAM Self-Learning: Implementation of YOLO for object Detection, Implementation of semantic segmentation for images.		
V	**Planning and Control in SDC**	5.1 Planning and Control: Architecture of planning and control, Traffic Prediction and routing. 5.2 Behavioral decision, Motion Planning and feedback control.	6	CO5
VI	**Applications of SDC**	6.1 DragonFly Model: Sensor Configuration and Software Architecture 6.2 Enabling Commercial Autonomous Space Robotic Explorers: Sensor configuration and its working. 6.3 Algorithm for YOLO object detection: Detecting objects in images and Detecting objects in videos	6	CO6

Textbooks:

1. Sumit Ranjan, Dr. S. Senthamilarasu - Applied Deep Learning and Computer Vision for Self- Driving Cars , Packt Publishing Ltd. 2020.
2. Shaoshan Liu, Liyun Li , Jie Tang, Shuang Wu, Jean-Luc Gaudiot - Creating Autonomous Vehicle System , Second Edition , Morgan & Claypool Publishers , 2018.
3. William Ribbens - Understanding- Automotive-Electronics , Butterworth-Heinemann Publisher, Fifth Edition, 1998.

Reference Books:

1. Markus Maurer ,J. Christian Gerdes, Barbara Lenz , Hermann Winner - Autonomous Driving Technical, Legal, Social Aspects , Springer Open, 2015.
2. Shaoshan Liu - Engineering Autonomous Vehicles and Robots, Wiley, 2020.

E-Resources:

1. Open Innovation in EVs: A case study of Tesla Motors https://www.diva-portal.org/smash/get/diva2:635929/FULLTEXT01.pdf
1. Autonomous vehicles Research report by MRCagney https://drive.google.com/drive/folders/1nxROagqwDKUpVMDLFPPgG7_DKakuyItf
1. Reinventing Safety: A Joint Approach to Automated Driving Systems Mercedes-Benz and Bosch

https://www.daimler.com/documents/innovation/other/vssa-mercedes-benz-and- bosch.pdf

Online Courses

1. https://digitaldefynd.com/best-self-driving-cars-courses/
2. https://www.classcentral.com/course/intro-self-driving-cars-13140

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC832	Satellite and Nano Satellite Communication	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC 832	Satellite and Nano Satellite Communication	20	20	40	60	2.5	--	--	100

Rationale : The Satellite and Nano Satellite Communication syllabus is crafted to provide students with an in-depth understanding of satellite communication principles, system design, and the emerging domain of small and nano satellite technologies. As global demand for space-based communication, navigation, and remote sensing grows, this course equips learners with both theoretical foundations and practical insights into orbits, link budgets, transponders, and miniaturized satellite platforms used in modern aerospace and defense industries.

Course Objectives:

1. To understand the basics of satellite communications and different satellite orbits
2. To provide an in-depth understanding of satellite communication system operation, launching techniques, and earth station technology
3. To Analyze and evaluate satellite link design
4. To review structure design, payload and space segment related to Nano satellite.

Course Outcomes:

1. Understand the basic concepts of satellite communication system and orbital parameters.

2. Explain various satellite sub-systems, earth station technologies and launching mechanisms.
3. Analyze and evaluate link budget and various performance parameters of satellite signal for proper communication.
4. Understand Nano satellite's structure design, payloads, Thermal control system and space segment

Prerequisite:

Analog Communication

Digital communication

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Overview of Satellite Systems, Orbits and Launching**	1.1 An overview of space and classification of satellite, orbital elements: apogee and perigee heights, semi-major axis, eccentricity, and mean anomaly, argument of perigee, inclination and right ascension of the ascending node, polar orbiting satellites, Kepler's first, second and third law, Orbital perturbations, effects of a non- spherical earth, atmospheric drag. 1.2 Sub-satellite point, predicting satellite position, antenna look angels, polar mount antenna, limits of visibility, near geostationary orbits, earth eclipse of satellite, sun transit outage. 1.3 Selection of launching site, launch window, zero and non-zero degree latitude launching, sea launch, Launchers: Polar Satellite Launch Vehicle (PSLV), Geostationary Satellite Launch Vehicle (GSLV), Reusable launch vehicles (RLV),Sounding rockets, Fuels used for launch Vehicles.	8	CO1

II	**Space Segment**	2.1 Satellite configuration, transponder sub-system, antenna sub- system, AOC sub- system, TT&C sub-system, power sub-system,thermal sub-system. 2.2 Reliability and quality assurance.	4	CO2
III	**Earth Station**	3.1 Design Consideration 3.2 General configuration: block diagram, receive only type earth, transmit-receive type earth station, antenna system, feed system, tracking system, LNA and HPA.	3	CO2
IV	**Satellite Losses and Links**	4.1 Atmospheric losses, ionospheric losses, transmission losses, feeder losses, antenna misalignment losses, rain attenuation, other impairments, antenna polarization, polarization of satellite signals, cross polarization discrimination, ionospheric depolarization, rain depolarization and ice depolarization, Isotropic radiated power and link budget. 4.2 System noise, antenna noise, amplifier noise temperature, amplifiers in cascade, noise factor, noise temperature of absorptive networks, Overall system noise temperature and carrier to noise ratio. 4.3 Saturation flux density, input back off, earth station HPA, output back off and satellite TWTA output. 4.4 Effects of rain, uplink rain-fade margin, downlink rain-fade margin, combined uplink and downlink C/N ratio and intermodulation noise	10	CO3
V	**Overview of nano satellite**	5.1 Introduction: Important transformation, Review of nano satellite, Global economics related to it, Evolution of nano satellite, ISRO's small satellite program and future Scenario. 5.2 Payloads for nano satellite: Types of payloads: Earth observation payload, communication payload and scientific payload. Design considerations for payloads.	6	CO4

		5.3 Nanosatellite structures: Function of satellite structure, Types of structure designs: Skin frame structure, Truss structure, Monocoque cylinders and Skin stringer structure, Overview for building of structure and materials for structures.		
VI	**Space segment for Nano satellite**	6.1 Thermal control system (TCS) implementation in nano satellite and it's testing for verification of TCS. Power system design for nano satellite. 6.2 Function and design consideration of Deployment mechanisms, Critical elements in deployment mechanisms, Overview of types of deployment mechanisms. 6.3 On board Computer and digital electronics (OBC): Block diagram of typical OBC, Overview of OBC Software and hardware, Telemetry and telecommand, Attitude control electronics 6.4 Quality, Quality assurance, product assurance and reliability analysis for Nano satellite	8	CO4

Text Books & References:

1. Dennis Roddy, ―Satellite Communications‖, 4th Ed., Mc. Graw-Hill International Ed. 2009.
2. M. Richharia, ―Satellite Communication Systems Design Principles‖, Macmillan Press Ltd. Second Edition 2003.
3. R. N. Mutangi, ― Satellite Communication‖, Oxford university press, 2016.
4. Gerard Maral and Michel Bousquet, ―Satellite Communication Systems‖, 4th Edition Wiley Publication
5. Gerard Maral, ―VSAT Networks‖, John Willy & Sons
6. Space technology Veterans, Quintessence of Nano satellite technology (small is big), Planet aerospace India,2020.
7. Timothy Pratt, Charles Bostian, and Jeremy Allmuti, ―Satellite Communications‖, John Willy & Sons (Asia) Pvt. Ltd. 2004
8. Wilbur L. Pritchard, Henri G. Suyderhoud, and Robert A. Nelson, ―Satellite Communication systems Engineering‖, Pearson Publication

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC833	Network Management in Telecommunication	3	-	-	3	-	-	3

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC833	Network Management in Telecommunication	20	20	40	60	2.5	--	--	100

Rationale:
This course provides an in-depth understanding of the principles, standards, and tools used in managing modern computer and communication networks. It aims to equip students with practical knowledge of protocols like SNMP, OSI and TMN models, network management architectures, and software tools essential for ensuring reliability, scalability, and performance of IT infrastructure. The course also explores advanced topics such as broadband and ATM network management, enabling learners to address real-world challenges in system monitoring and service-level assurance.

Course Objectives :

1. To introduce the concepts of network design, system/service management, and economic considerations in achieving Service Level Agreements (SLAs).
2. To understand OSI and ISO network management standards, architectures, and associated protocols and models.
3. To explore SNMP versions (v1, v2, v3), their architecture, operations, and security features for effective internet management.
4. To study the framework and functionality of Telecommunication Management Networks (TMN).
5. To analyze the tools, utilities, and applications used in modern network management systems, including commercial and open-source NMS.
6. To understand advanced topics like ATM network management, event correlation, and distributed network monitoring systems.

Course Outcomes:

By the end of the course, students will be able to:

1. Analyze network design strategies and management challenges in real-world case studies considering SLA and cost-efficiency.
2. Describe the OSI network management model, its layers, functions, and associated communication standards such as ASN.1 and TLV.
3. Explain SNMP protocols (v1/v2/v3), RMON concepts, and their application in network monitoring and management.
4. Illustrate the TMN framework, functional models, and explain the role of OSI layers in telecommunication management.
5. Utilize network management tools to monitor traffic, analyze errors, and evaluate protocol statistics through SNMP and analyzers.
6. Design and evaluate network management systems and applications, including ATM network management and event correlation techniques.

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction of Network Management**	Introducing Network Design Concepts: Case histories on network, system and service management, Network design based on economy and SLA-based services. Challenges of IT managers, Network Management: Goals, organization and functions, Network management architecture, organization network and management perspectives **Self learning:** Case studies of real-world network and service management systems	6	CO1
II	**OSI Network Management**	Network Management standards,OSI Network Management model,Network Management layers,ISO Network Management functions,Communication model and functional model,Abstract Syntax Notation One (ASN.1): Terminology, symbols, and conventions. TLV encoding structure	6	CO2

		Self learning: Use of ASN.1 in network protocols (e.g., SNMP, LDAP)		
III	**Internet Management**	**SNMP model**: SNMP Organizational model, System overview, Information model, Management of Information Base **SNMP v1**: SNMP Communication model- SNMP architecture, Administrative model, SNMP Protocol specifications, SNMP operations, SNMP Functional model **SNMPv2**: Major changes in SNMPv2, SNMPv2 architecture, SNMPv2 Management Information Base, SNMPv2 protocol, Compatibility with SNMPv1 **SNMPv3**:Key features, SNMPv3 architecture, SNMPv3 applications, Security, security model, message format, SNMPv3 User- based Security Model, Access control (VACM) **RMON:** What is RMON? RMON 1, RMON 2 **Self learning:** Practical application of RMON in LAN monitoring and performance evaluation	10	CO3
IV	**Telecommunication Management Networks(TMN)**	Definition of TMN , TMN framework, TMN functional model, TMN Conceptual model, OSI functionality in TMN, TMN management services architecture and TMN implementation. **Self learning:** TMN architecture mapping with OSI model	4	CO4
V	**Network Management Tools and Applications**	System Utilities for Network Management: Basic tools, SNMP tools and Protocol Analyser, Network Statistics and Measurements: Traffic load, Protocol statistics, Data and Error Statistics, NMS Design: Functional requirements, NMS Client design and NMS Server,	9	CO5

		architecture, Distributed Management approaches Network Management Systems: Commercial and Open-source NMSs, Network Management Applications: Fault, Configuration, Accounting, Performance and Security (FCAPS), Event Correlation Techniques: Rule-based reasoning, Model-based reasoning, Case- based reasoning, Codebook, State Transition Graph model and Finite State Machine Model, Report Management, Policy-based Management and Service Level Management **Self learning:** Open-source vs commercial NMS: Zabbix, SolarWinds, PRTG		
VI	**Broadband Network Management**	Broadband networks and services, ATM Technology – VP, VC, ATM Packet, Integrated service, ATM LAN emulation, Virtual LAN, ATM Network Management – ATM network reference model, Integrated Local Management Interface, role of SNMP and ILMI in ATM, ATM Management Information Base, M1, M2, M3, M4 interfaces **Self learning:** ATM technology: VP, VC, and ATM cell structure	4	CO6

Text books

1. Mani Subramaniam, *Network Management Principles and Practice*, New Delhi: Pearson, 2010.
2. Alexander Clemm, *Network Management Fundamentals*, Cisco Press, December 2006, ISBN-13: 978-158720137.
3. Benoit Claise and Ralf Wolter, *Network Management: Accounting and Performance Strategies*, CISCO Press, 2007.
4. J. Richard Burke, *Network Management: Concepts and Practice, A Hands-On Approach*,Pearson Education India, 2008, ISBN-13: 978-8131718490.
5. Salh Aiidarons, Thomas Plevoyak, *Telecommunications Network Technologies and Implementations*, Eastern Economy Edition, New Delhi:IEEE Press, 1998.

6. Henry Haojin Wang, *Telecommunication Network Management*, McGraw Hill, 1999.

Online Learning Resources:-

1. https://www.youtube.com/watch?v=liBB_Q7Go5k
2. https://www.youtube.com/watch?v=xdUjwlyyi9U
3. https://www.youtube.com/watch?v=aQGeSDauRso
4. https://nptel.ac.in/courses/117/101/117101050/
5. https://nptel.ac.in/courses/106/105/106105183/

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC834	Microstrip Antenna	3	-	-	3	-	-	3

		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		IAT 1	IAT 2	Total					
ETC 834	Microstrip Antenna	20	20	40	60	2.5	--	--	100

Rationale: This course provides a foundational understanding of Microstrip Antennas, focusing on their design, analysis, and application in modern wireless systems. It equips students with the skills to design compact, efficient antennas and prepares them for industry roles in RF and communication engineering.

Course Objectives :

1. Understand the fundamentals of Microstrip Antennas (MSAs) including their types, characteristics, advantages, disadvantages, and applications.
2. Explore key antenna performance metrics such as reflection coefficient, VSWR, return loss, directivity, gain, and radiation patterns.
3. Gain knowledge on design principles and parameters for Rectangular and Circular Microstrip Antennas (RMSA & CMSA).
4. Investigate the influence of design variables on antenna performance through parametric studies of RMSA and CMSA.
5. Study techniques for compact and broadband antenna design including shorting techniques, U-slots, and multiresonator configurations.

6. Analyze modern applications and polarization techniques including circularly polarized antennas, wearable, fractal, MIMO, and reconfigurable MSAs.

Course Outcomes:

1. Describe the fundamental characteristics and types of MSAs and explain their practical advantages and limitations.
2. Interpret antenna performance parameters such as VSWR, return loss, radiation pattern, and SAR, and their impact on antenna design.
3. Design and analyze Rectangular and Circular MSAs using theoretical formulas for resonant frequency, dimensions, and input impedance.
4. Evaluate the effects of parametric variations (substrate, feed location, dimensions) on antenna performance using simulation or analytical tools.
5. Implement compact and broadband design techniques to enhance antenna performance for specific applications.
6. Design circularly polarized MSAs and explore application-specific designs such as wearable, reconfigurable, and MIMO antennas.

Prerequisite:

Electromagnetic and Antenna
Microwave Engineering

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to Microstrip Antennas**	Types of MSA's, Characteristics of MSA's, Advantages and Disadvantages, Applications of MSA's. Reflection coefficient, VSWR, Return loss, Impedance mismatch, VSWR Bandwidth, Gain, Directivity, Antenna efficiency, E-Plane and H-Plane radiation pattern, Co and Cross polarization, Specific absorption rate (SAR), Axial ratio. Feeding Techniques, brief introduction to	5	CO1

		Methods of Analysis, Surface waves, Various substrates with dielectric constant for MSA. **Self learning:** Comparison between Microstrip and conventional antennas		
II	**Design of Rectangular Microstrip Antenna (RMSA)**	Design considerations of RMSA: Resonant frequency, Voltage and Current variation, Radiation Pattern, Calculation of effective dielectric constant, actual and effective length, width, feed point location. Parametric Study of RMSAs : Effect of - feed point location, width of RMSA(W), height of substrate(h), dielectric constant(Ɛr), probe diameter, finite ground plane, loss tangent. Analysis of Higher order modes of RMSA. **Self learning: Practical examples of RMSA in communication devices**	8	CO2
III	**Design of Circular Microstrip Antenna (CMSA)**	Design considerations of CMSA: Resonant frequency, Input Impedance and Voltage Distribution, Radiation Pattern, Calculation of effective dielectric constant, actual and effective radius, feed point location. Parametric Study of CMSAs : Effect of loss tangent Analysis of Higher order modes of CMSA. **Self learning: CMSA applications in radar and GPS**	8	CO3
IV	**Compact and Broadband Techniques**	Compact Techniques for RMSA and CMSA:Introduction, Compact Shorted RMSA, Partially Shorted RMSA, Effect of Dimensions of RMSA with a Single Shorting Post, Effect of the Position of the Single Shorting Post. Broadband Techniques for RMSA and CMSA: Planar Multiresonator configurations (Radiating and Non-radiating Gap coupled concept), Electromagnetically coupled MSA's, Stacked Multiresonator Rectangular Patches on Thick Substrates, U slot technique..	8	CO4

		Self learning: Review of multiband antenna designs		
V	**Circularly Polarized MSAs**	Methods to achieve Circular Polarization in MSA : single feed and dual feed. Design procedure for single feed circularly polarized MSA (RMSA & CMSA). **Self learning:Applications of circular polarization in satellite and RFID systems**	5	CO5
VI	**Applications of MSA**	Introduction: Wearable and Fractal Antennas for wireless communication systems, MIMO Patch Antenna, Reconfigurable Antenna, Implanted Antennas in the medical field. **Self learning:Role of MSAs in 5G and IoT**	5	CO6

Text Books:

1. Girish Kumar, K. P. Ray, Broadband Microstrip Antennas, Artech House, 2003.
2. Constantine A. Balanis, Antenna Theory: Analysis and Design, John Wiley Publication 4th Edition.
3. Sabban, Albert. Wearable Communication Systems and Antennas for Commercial, Sport and Medical Applications. IOP Publishing 2018. https://dx.doi.org/10.1088/2053-2563/aade55
4. Abed, M. J. Abu-AlShaer, and A. M. Jawad, "Fractal Antennas for Wireless Communications", in Modern Printed- Circuit Antennas. London, United Kingdom: IntechOpen, 2020 [Online]. Available: https://www.intechopen.com/chapters/71491 doi:10.5772/intechopen.90332
5. Sharawi Mohammad S., Printed MIMO antenna engineering, Artech House Publishers, 2014.
6. J. T. Bernhard, Reconfigurable Antennas. San Rafael, CA, USA: Morgan and Claypool Publishers, 2007.
7. Rahmat-Samii, Yahya, Kim, Jaehoon, Implanted Antennas in Medical Wireless Communications. United States: Morgan & Claypool Publishers, 2006. https://doi.org/10.2200/S00024ED1V01Y200605ANT001

Reference books

1. Ramesh Garg, Prakash Bhartia, Inder J. Bahl, A. Ittipiboon, Microstrip Antenna Design Handbook, Artech House, 2001.
2. Kin-Lu Wong, Compact and Broadband Microstrip Antennas, John Wiley & Sons Inc, United States, 2002.

3. Kai Fong Lee, Kwai Man Luk, Hau Wah Lai, Microstrip Patch Antennas, World Scientific; 2nd edition.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETC835	Augmented and Virtual Reality	03	- -	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam				
		IAT 1	IAT 2	Total					
ETC835	Augmented and Virtual Reality	20	20	40	60	2.5	--	–	100

Rationale: This course introduces students to the principles, architecture, and development of Augmented and Virtual Reality systems. It aims to equip learners with both theoretical understanding and practical skills in designing immersive environments by integrating visual perception, tracking technologies, calibration, and application development. Additionally, it promotes awareness of ethical and human factors, enabling students to create responsible and impactful AR/VR solutions.

Course Objectives: The course aims:

1. To learn the underlying concepts of Augmented and Virtual Reality and primitives of computer graphics.
2. To understand the use of hardware devices in AR-VR systems.
3. To understand the tracking system in AR.
4. To apply concept of calibration and registration of different components in AR system
5. To design AR-VR applications.
6. To understand the use of AR-VR in interdisciplinary immersive applications

Course Outcomes: On successful completion of this course, learner /student will be

able to:

1. Identify and compare different Virtual and Augmented Reality Technologies and apply modelling techniques.
2. Identify and use AR-VR hardware components.
3. Apply concepts of Computer Vision for tracking in AR Systems.
4. Apply calibration techniques and registration for components in AR.
5. Design AR-VR application
6. Apply insights of AR-VR in different applications.

Prerequisite: Programming Language, Computer Graphics

DETAILED SYLLABUS:

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
I	**Introduction to Augmented and Virtual Reality**	Definition and Scope, A Brief History of Augmented and Virtual Reality, AR-VR Architecture, Challenges with AR-VR, AR-VR systems and functionality, Types of Augmented Reality Application (Location Based AR Apps Marker-Based AR Applications). Understanding Virtual Space and Geometry: coordinate systems, Geometric Modelling, 2D transformations, 3D rotation and 6 degree of freedom, View Transformation, projective transformation, Related fields: MR, XR and ubiquitous computing and their comparison. **Self learning:** Extended Reality (XR), Mixed Reality (MR) comparison	5	CO1
II	**Visual Physiology, perception and Interaction**	Mechanics of Sight: the visual pathway, spatial vision and depth cues. Display fundamentals, optical architecture.	5	CO2

		Augmenting displays. Multimodal Displays; Visual Perception; Spatial Display Model; Visual Displays. Mechanics of hearing, audio displays. Augmented and Virtual reality Hardware. **Self learning:** Spatial auditory displays and binaural hearing		
III	**Tracking and Computer Vision for AR**	Characteristics of Tracking Technology; Stationary Tracking Systems; Mobile Sensors; Optical Tracking; Sensor Fusion; Marker Tracking, infrared tracking, Natural feature tracking by detection. **Self learning:** Computer vision libraries (OpenCV, Vuforia)	10	CO3
IV	**Calibrations and Registration**	Camera projection and setup for AR. Camera calibration techniques. Registration **Self learning:** Camera intrinsic vs extrinsic parameters	6	CO4
V	**AR-VR Application Development**	AR-VR Application Requirements, Software engineering requirements, AR-VR Design Principles, Data Flow, Scene Graphs; Developer Support: Parameter Configuration, Tools used in AR-VR development. **Self learning:** GUI design in AR applications	7	CO5
VI	**Applications of AR-VR and Human Factors, Legal and Social Consideration**	Applications of AR-VR in: Edutainment, Medical, Military, Production and Manufacturing, Navigation, Astronomical Observation, E-commerce; What are Human Factors, Physical Side Effects, Visual Side Effects, Legal Considerations, Moral and Ethical Considerations.	6	CO6

		Self learning: Case studies on AR in healthcare and education		

Textbooks:

1. John Vince, "Virtual Reality Systems", Pearson publication
2. Tony Parisi, "Learning Virtual Reality", O'REILLY'
3. Dieter Schmalsteig and Tobias Hollerer, "Augmented Reality- Principles and Practice", Pearson Education, Inc. 2016 Edition.
4. Chetankumar G Shetty, "Augmented Reality- Theory, Design and Development", Mc Graw Hill, 2020 Edition.
5. Alan B. Craig, "Understanding Augmented Reality – Concepts and Applications", Morgan Kaufmann, Elsevier, 2013 Edition.

References:

1. Borko Furht, "Handbook of Augmented Reality", Springer.
2. Erin Pangilinan, Steve Lukas, and Vasanth Mohan, "Creating Augmented and Virtual Realities- Theory and Practice for Next-Generation Spatial Computing", O'Reilly Media, Inc., 2019 Edition.
3. Jens Grubert, Dr. Raphael Grasset, "Augmented Reality for Android Application Development", PACKT Publishing.

Online References:

1. www.nptel.ac.in
2. www.coursera.org

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ETL805	Optical Communication and Networks Laboratory	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT 1	IAT 2	Total				
ETL805	Optical Communication and Networks Laboratory	--	--	--	--	25	25	50

Lab Objectives:

The objective of the course is-

1. To introduce students to the measurement of key optical fiber parameters like numerical aperture, dispersion, and link loss.
2. To develop skills in analyzing the performance of single-mode and multimode optical fibers.
3. To enable evaluation of optical links using various light sources, detectors, and amplifiers.
4. To familiarize students with point-to-point and wide-area optical network design using simulation tools.
5. To expose students to the architecture and simulation of advanced WDM and FSO systems.
6. To promote real-world problem-solving, teamwork, and tool-based learning through fiber network design activities.

Lab Outcomes:

Students will be able to

1.Analyse different parameters for propagation of light inside optical fiber.

2. Examine fiber optic links to find propagation losses.

3. Examine the performance of optical sources and detectors.

4. Design optical fiber link for power budgeting.

5. Explore concepts of designing and operating principles of optical communication networks.

6. To design different optical systems.

DETAILED SYLLABUS:

Suggested List of Experiments-

1. Calculation of Numerical aperture for SMF and MMF
2. Calculation of dispersion for given fiber and its measurement
3. Calculation of link Loss for given link
4. Performance analysis of Single mode fiber
5. Performance analysis of multimode fiber
6. Performance Analysis of Optical Link with Different Sources
7. Performance Analysis of Optical Link with Different Detectors
8. Performance Analysis of Optical Amplifier
9. Designing of point-to-point optical network using tools or software
10. Designing of Metro network/WAN using tools or software
11. Designing of WDM network using tools or software
12. Designing of FSO using tools or software

Note: Small Project on implementation of indoor fiber optical network or free space optical network can be considered as a part of term-work.

Sr. No.	List of the Experiment	Hrs
1	To study fiber optic Analog Link and Digital Link	2
2	To study intensity modulation.	2
3	To study measurement of Bending Loss.	2

4	To measure numerical aperture(NA) of the fiber using virtual lab	2
5	To design Step Index fiber.	2
6	To compute overall signal attenuation, signal attenuation per km, overall signal attenuation.	2
7	To plot the characteristic curve for LED .	2
8	To compute responsivity, received optical power, number of photons received, Thermal noise, Shot noise power and S/N Ratio for PIN photodiode.	2
9	To study packet transfer in fiber optic network using Cisco Packet Tracer.	2
10	To study Link Power Budget.	2
11	Course Project :e.g. GUI based project,Designing of point-to-point optical network using tools or software,Designing of network using Cisco Packet Tracer	2

Assessment:

Term Work: Term Work shall consist of at least 10 to 12 practicals' based on the above list. Also, Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETL806	Major Project-II	--	12	--	--	04	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam.			
		IAT 1	IAT 2	Total				
ETL806	Major Project-II	--	--	--	--	50	100	150

Rationale: The primary objective is to meet the milestones formed in the overall project plan decided in Project - I. The idea presented in Project -I should be implemented in Project -II with results, conclusion and future work. The project will culminate in the production of a thesis by each individual student.

Guidelines:

Project Report Format:

At the end of the semester the student needs to prepare a project report which should be prepared as per the guidelines issued by the University. Along with the project report a CD containing: project documentation, Implementation code, required utilities, Software_s and user Manuals need to be attached.

Term Work:

Student has to submit weekly progress report to the internal guide and the internal guide has to keep a track on the progress of the project and also has to maintain the attendance report. This progress report can be used for awarding the term work marks. In case of industry projects, visit by internal guide will be preferred to get the status of project. Distribution of marks for term work shall be as follows:

a) Weekly Attendance on Project Day
b) Project work contributions as per objective
c) Project Report (Hard Bound)
d) Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

Oral & Practical:

Oral & Practical examination of Project- II should be conducted by Internal and External examiners approved by University. Students have to give presentation and demonstration on the Project-II.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
OEC 7501	Product Life Cycle Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		IAT 1	IAT 2	Total					
OEC 7501	Product Life Cycle Management	20	20	20	80	03	--	--	100

Course Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Course Outcomes: Learner will be able to…

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):** Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process.	09
03	**Product Data Management (PDM):** Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for	05

06	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05
Total		39

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, ImmonenAnselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
OEC 7502	Reliability Engineering	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		IAT 1	IAT 2	Total					
OEC 7502	Reliability Engineering	20	20	20	80	03	--	--	100

Course Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Course Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08

02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05
Total		39

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
OEC 7503	Management Information System	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		IAT 1	IAT 2	Total					
OEC 7503	Management Information System	20	20	20	80	03	--	--	100

Course Objectives:

1. The course is a blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Course Outcomes: Learner will be able to…

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytical CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8
	Total	39

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REFERENCES:

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
OEC7504	Design of Experiments	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		IAT 1	IAT 2	Total					
OEC 7504	Design of Experiments	20	20	20	80	03	--	--	100

Course Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Course Outcomes: Learner will be able to…

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06

02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
03	**Two-Level Factorial Designs** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General 2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	**Response Surface Methods and Designs** 5.1 Introduction to Response Surface Methodology 5.2 The Method of Steepest Ascent 5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	07
06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04
Total		39

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
OEC7505	Operations Research	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		IAT 1	IAT 2	Total					
OEC 7505	Operations Research	20	20	20	80	03	--	--	100

Course Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Course Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model	05

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
OEC7506	Cyber Security and Laws	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		IAT 1	IAT 2	Total					
OEC7506	Cyber Security and Laws	20	20	20	80	03	--	--	100

Course Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Course Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for	9

	Organizational Security Policies and Measures in Mobile Computing Era, Laptops	
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6
	Total	39

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kenneteh J. Knapp, *Cyber Security & Global Information Assurance*

Information Science Publishing.
7. William Stallings, *Cryptography and Network Security,* Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR: https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional: https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer - professionals-33538

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
OEC7507	Disaster Management and Mitigation Measures	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		IAT 1	IAT 2	Total					
OEC 7507	Disaster Management and Mitigation Measures	20	20	20	80	03	--	--	100

Course Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Course Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	**Natural Disaster and Manmade disasters:** 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion **2.2** Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	**Disaster Management, Policy and Administration** 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. **.2** Policy and administration: Importance and principles of disaster management policies, command and co- ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06

04	**Institutional Framework for Disaster Management in India:** 4.1 Importance of public awareness, Preparation and execution of emergency management programme. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	**Financing Relief Measures:** 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	09
06	**Preventive and Mitigation Measures:** 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06
Total		39

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
OEC7508	Energy Audit and Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		IAT 1	IAT 2	Total					
OEC 7508	Energy Audit and Management	20	20	20	80	03	--	--	100

Course Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Course Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures.

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03
	Total	39

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
OEC7509	**Development Engineering**	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		IAT 1	IAT 2	Total					
OEC 7509	**Development Engineering**	20	20	20	80	03	--	--	100

Course Objectives:

1. To familiarise the characteristics of rural Society and the Scope, Nature and Constraints of rural Development
2. To provide an exposure to implications of 73rdCAA on Planning, Development and Governance of Rural Areas
3. An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals
4. To familiarise the Nature and Type of Human Values relevant to Planning Institutions

Course Outcomes: Learner will be able to…

1. Demonstrate understanding of knowledge for Rural Development.
2. Prepare solutions for Management Issues.
3. Take up Initiatives and design Strategies to complete the task
4. Develop acumen for higher education and research.
5. Demonstrate the art of working in group of different nature
6. Develop confidence to take up rural project activities independently.

Module	Contents	Hrs
1	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	**08**
2	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development.	**06**
3	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development	**07**
4	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	**04**
5	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom	**10**

6	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	**04**

Reference

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rdGoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, WashingtonHow, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150
9. Watson, V. Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
OEC8401	Project Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		IAT 1	IAT 2	Total					
OEC8401	Project Management	20	20	20	80	03	--	--	100

Course Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Course Outcomes: Learner will be able to…

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference.

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	8
06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **6.2 Closing the Project:**	6

	Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	
Total		39

REFERENCES:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Ed.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
OE8402	Finance Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		IAT 1	IAT 2	Total					
OE8012	Finance Management	20	20	20	80	03	--	--	100

Course Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Course Outcomes: Learner will be able to…

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial	06

	Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09

04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches— Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Total	39

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
OEC 8403	Entrepreneurship Development and Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		IAT 1	IAT 2	Total					
OEC 8403	Entrepreneurship Development And Management	20	20	20	80	03	--	--	100

Course Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Course Outcomes: Learner will be able to…

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership	04

	Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship.	
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08

05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05
Total		39

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
OEC8404	Human Resource Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		IAT 1	IAT 2	Total					
OEC 8404	Human Resource Management	20	20	20	80	03	--	--	100

Course Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Course Outcomes: Learner will be able to…

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
02	**Organizational Behavior (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness	7
	• Perception: Attitude and Value, Effect of perception on Individual Decision- making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	
03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	6
04	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job- Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	5

05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
06	**HR & MIS** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10
Total		39

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
OEC8405	Professional Ethics and CSR	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		IAT 1	IAT 2	Total					
OEC8405	Professional Ethics and CSR	20	20	20	80	03	--	--	100

Course Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Course Outcomes: Learner will be able to…

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource	08

	Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources.	
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08
Total		39

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
OEC8406	Research Methodology	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		IAT 1	IAT 2	Total					
OEC8406	Research Methodology	20	20	20	80	03	--	--	100

Course Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Course Outcomes: Learner will be able to…

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	**09**

02	**Types of Research** **2.1.** Basic Research **2.2.** Applied Research **2.3.** Descriptive Research **2.4.** Analytical Research **2.5.** Empirical Research **2.6** Qualitative and Quantitative Approaches	**07**
03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem	**08**
	b. Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f.** Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached **6.2** Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	**04**
Total		39

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
OEC8407	IPR and Patenting	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		IAT 1	IAT 2	Total					
OEC8407	IPR and Patenting	20	20	20	80	03	--	--	100

Course Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Course Outcomes: Learner will be able to…

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05

02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement **Indian Scenario of IPR:** Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:** Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non- patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07
Total		39

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** IPR: Drafting, Interpretation of Patent Specifications and Claims**,** New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
OEC8408	Digital Business Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		IAT 1	IAT 2	Total					
OEC8408	Digital Business Management	20	20	20	80	03	--	--	100

Course Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Course Outcomes: The learner will be able to …..

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business-** Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09

2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08
Total		39

References:

1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-en OECD Publishing

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
OEC8409	Environmental Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		IAT 1	IAT 2	Total					
OEC8409	Environmental Management	20	20	20	80	03	--	--	100

Course Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Course Outcomes: Learner will be able to…

1. Understand the concept of environmental management.
2. Understand global environment concerns.
3. Understand ecosystem and interdependence, food chain etc.
4. Understand environment quality management and Corporate Environmental responsibilities
5. Understand and interpret environment related legislations.

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03
Total		39

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management, T V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
OJT899	Internship/ Apprenticeship	-	8	-	-	4	-	4

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		IAT1	IAT2	Total				
OJT899	Internship/ Apprenticeship	--	--	--	--	25		25

Course Objectives:

The course is designed so as to expose the students to industry environment and to take up on-site assignment as trainees or interns. But the volatile dynamics of industry requirements and its own way of scrutinizing students and providing them the opportunities prevent students from getting equal out-house internship opportunities. Consequently, weaker students get fewer opportunities while bright students get more. Therefore, to create equal opportunities among students, in-house internship is strengthened even though the college show strong preference for out-house internship.

Course Outcomes:

1. Demonstrate professional and ethical responsibility.
2. Understand the impact of engineering solutions in a global, economic, environmental and societal context.
3. Develop the ability to engage in research and to involve in life-long learning.
4. Comprehend contemporary issues

Internship Modes:

1. **Track A – Internship (External)**: Traditional industry internship outside campus.

2. **Track B – Apprenticeship (In-house)**: Skill development with industry mentor within the college, especially for domains like AI/ML, DevOps, Cybersecurity, etc.

Internship vs Apprenticeship

Aspect	**Internship**	**Apprenticeship**
Nature	Typically short-term, focused on exposure and learning	More structured, skill-based, focused on hands-on experience
Duration	4–8 weeks (can vary)	4-6 months
Certification	Ends with a formal certificate	Ends with a formal certificate
Supervision	Faculty or external	Usually industry mentor-drive
Alignment	Curriculum-aligned but flexible	Skill- and competency-based learning, aligned with NSQF/AICTE

A. Internship (Industry/Research Labs/Startups)

- Students are placed through T&P cell initiatives or self-arranged industry internships.
- Faculty or Industry mentor assigned for weekly monitoring.

Required Deliverables:

- Weekly interaction record (date, time, discussion summary)
- Weekly feedback form from industry mentor
- Final Internship Certificate from industry
- Internship Report

B. Apprenticeship (Department-Driven)

Apprenticeships are designed to ensure equitable access to industry-relevant learning for all students. These are not substitutes for value-added training but structured, outcome-driven engagements that simulate professional project environments.

Projects must align with:

- Smart India Hackathon problem statements (past/current)
- NITI Aayog challenges or national-level missions

Required Deliverables:

- Skill-oriented training with defined outcomes

- Defined problem statement.
- Faculty and Industry mentor assigned for weekly monitoring.
- Project work log (weekly).
- Final Project Report Mentor evaluation sheet.