AC-01- Item No. 2.0, 2.5, 3.0 & 3.5 dated 24th July 2025

Department of Bachelor of Vocational Studies
Curriculum FY to B.Voc Big database and Cloud Computing OLD for A.Y 2023-24

First Year to Final Year Syllabus

Prepared by: Board of Studies for Computer Engineering

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

Revision : 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: The curriculum design is based on The National Skills Qualifications Framework (NSQF). NSQF in India is a ten-level structure that distinctly integrates both a General Component, covering foundational subjects like communication and IT skills, and a Skill Component, focused on vocational training aligned with industry-specific Qualification Packs (QPs) and National Occupational Standards (NOSs).

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 **On Job Training**—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. About General Component and Skill Component:

This focuses on **foundational knowledge and transferable skills**, often aligned with **general education goals**. Such as cognitive, communication and analytical abilities. Usually constitutes **30–40% of the total credit load. Skill Component** is aligned to **industry-specific job roles** based on **Qualification Packs (QPs)** developed by Sector Skill Councils (SSCs). Makes up **60–70% of the total credits**—emphasizing hands-on skill acquisition

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 Chief Operating Officer

Shree L. R. Tiwari College of Engineering Rahul Education

Contents

A. Abbreviations

G	General Education Component
S	Skill Component
BV	B.Voc
BDCC	Big Database and Cloud Computing
OJT	On Job Training
MP	Mini Project

Program Structure for First Year Big Database and Cloud Computing

UNIVERSITY OF MUMBAI (With Effect from 2023-2024)
Semester I

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
General Education Component								
22101	Professional Skill-I (Communication skills)	3	--	1*	3	--	1	4
22102	Applied Mathematics	3	--	1*	3	--	1	4
22103	Object Oriented Programming – C++	3	2	--	3	1	--	4
	Total	**12**	**2**	**2**	**12**	**1**	**2**	**12**
Skill Component								
22 104	Data Structures and Algorithm	3	2	--	3	1	--	4
22105	Computer Network	3	2	--	3	1	--	4
22106	Operating System	3	2	--	3	1	--	4
22107	On-Job Training/ Skill based Internship	--	12	--	--	6#	--	6
	Total	**12**	**18**	**--**	**9**	**9**	**--**	**18**
Grand Total		**24**	**20**	**2**	**21**	**10**	**2**	**30**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract & oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg					
General Education Component									
22101	Professional Skill-I (Communication skills)	10	10	10	40	2	--	--	50
22102	Applied Mathematics	20	20	20	80	3	25	--	125
22103	Object Oriented Programming – C++	20	20	20	80	3	25	25	150
Skill Component									
22 104	Data Structures and Algorithm	20	20	20	80	3	25	25	150
22105	Computer Network	20	20	20	80	3	25	25	150
22106	Operating System	20	20	20	80	3	25	25	150
22107	On-Job Training/ Skill based Internship	--	--	--	--	--	50#	--	50
Total		--	--	**110**	**440**	--	**175**	**100**	**825**

*Should be conducted batch wise

# indicates practical and oral marks includes report and presentation

Program Structure for First Year Big Database and Cloud Computing
UNIVERSITY OF MUMBAI (With Effect from 2023-2024)
Semester II

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
General Education Component								
22201	Professional Skill-II (Business communication Ethics)	3	--	1*	3	--	1	4
22202	Probability and Statistics	3	--	1*	3	--	1	4
22203	Introduction to Data Science	3	2	--	3	1	--	4
	Total	**12**	**2**	**2**	**12**	**1**	**2**	**12**
Skill Component								
22 204	Advanced Operating System	3	2	--	3	1	--	4
22205	Introduction to Cloud Computing	3	2	--	3	1	--	4
22206	Software Engineering	3	2	--	3	1	--	4
22207	On-Job Training/ Skill based Internship	--	12	--	--	6#	--	6
	Total	**12**	**18**	**--**	**9**	**9**	**--**	**18**
Grand Total		**24**	**20**	**2**	**21**	**10**	**2**	**30**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract & oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg					
General Education Component									
22201	Professional Skill-II (Business communication Ethics)	10	10	10	40	2			50
22202	Probability and Statistics	20	20	20	80	3	25	--	125
22203	Introduction to Data Science	20	20	20	80	3	25	25	150
Skill Component									
22 204	Advanced operating system	20	20	20	80	3	25	25	150
22205	Introduction to Cloud Computing	20	20	20	80	3	25	25	150
22206	Software Engineering	20	20	20	80	3	25	25	150
22207	On-Job Training/ Skill based Internship	--	--	--	--	--	50#	--	50
Total		**--**	**--**	**110**	**440**	**--**	**175**	**100**	**825**

*Should be conducted batch wise

# indicates practical and oral marks includes report and presentation

Program Structure for First Year Big Database and Cloud Computing

UNIVERSITY OF MUMBAI (With Effect from 2023-2024)
Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
General Education Component								
22301	Professional Skill-III (Entrepreneurship)	3	--	1*	3	--	1	4
22302	Computer Organization and architecture	3	--	1*	3	--	1	4
22303	Statistics for Data Science	3	2	--	3	1	--	4
	Total	**12**	**2**	**2**	**12**	**1**	**2**	**12**
Skill Component								
22304	Python Programming	3	2	--	3	1	--	4
22305	Database Management Systems	3	2	--	3	1	--	4
22306	Web Development	3	2	--	3	1	--	4
22307	On-Job Training/ Skill based Internship	--	12	--	--	6#	--	6
	Total	**12**	**18**	**--**	**9**	**9**	**--**	**18**
Grand Total		**24**	**20**	**2**	**21**	**10**	**2**	**30**

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Pract & oral**	**Total**
		Internal Assessment			**End Sem. Exam**	**Exam. Duration (in Hrs)**			
		Test 1	**Test 2**	**Avg**					
General Education Component									
22301	Professional Skill-III (Entrepreneurship)	10	10	10	40	2	--	--	50
22302	Computer Organization and architecture	20	20	20	80	3	25	--	125
22303	Statistics for Data Science	20	20	20	80	3	25	25	150
Skill Component									
22304	Python Programming	20	20	20	80	3	25	25	150
22305	Database Management Systems	20	20	20	80	3	25	25	150
22306	Web Development	20	20	20	80	3	25	25	150
22307	On-Job Training/ Skill based Internship	--	--	--	--	--	50#	--	50
Total		--	--	**110**	**440**	--	**175**	**100**	**825**

*Should be conducted batch wise and

# indicates practical and oral marks includes report and presentation

Program Structure for First Year Big Database and Cloud Computing

UNIVERSITY OF MUMBAI (With Effect from 2023-2024)
Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
General Education Component								
22401	Professional Skill-IV (Aptitude and Logic Building)	3	--	1*	3	--	1	4
22402	Soft Computing	3	--	1*	3	--	1	4
22403	Information Storage Concept	3	2	--	3	1	--	4
	Total	**12**	**2**	**2**	**12**	**1**	**2**	**12**
Skill Component								
22404	Data Mining and Data ware Housing	3	2	--	3	1	--	4
22405	Introduction to Big Data	3	2	--	3	1	--	4
22406	Network Security & Cryptography	3	2	--	3	1	--	4
22407	On-Job Training/ Skill based Internship	--	12	--	--	6#	--	6
	Total	**12**	**18**	**--**	**9**	**9**	**--**	**18**
Grand Total		**24**	**20**	**2**	**21**	**10**	**2**	**30**

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Pract & oral**	**Total**
		Internal Assessment			**End Sem. Exam**	**Exam. Duration (in Hrs)**			
		Test 1	**Test 2**	**Avg**					
General Education Component									
22401	Professional Skill-IV (Aptitude and Logic Building)	10	10	10	40	2			50
22402	Soft Computing	20	20	20	80	3	25	--	125
22403	Information Storage Concept	20	20	20	80	3	25	25	150
Skill Component									
22404	Data Mining and Data Warehousing	20	20	20	80	3	25	25	150
22405	Introduction to Big Data	20	20	20	80	3	25	25	150
22406	Network Security & Cryptography	20	20	20	80	3	25	25	150
22407	On-Job Training/ Skill based Internship	--	--	--	--	--	50#	--	50
Total		**--**	**--**	**110**	**440**	**--**	**175**	**100**	**825**

*Should be conducted batch wise and

# indicates practical and oral marks includes report and presentation

Program Structure for First Year Big Database and Cloud Computing

UNIVERSITY OF MUMBAI (With Effect from 2023-2024)
Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
General Education Component								
22501	Professional Skill-V (R-Programming)	3	--	1*	3	--	1	4
22502	Management Information System	3	--	1*	3	--	1	4
22503	Information Retrieval system	3	2	--	3	1	--	4
	Total	**12**	**2**	**2**	**12**	**1**	**2**	**12**
Skill Component								
22504	Machine Learning-1	3	2	--	3	1	--	4
22505	Cloud Network and Security	3	2	--	3	1	--	4
22506	Big data analytics	3	2	--	3	1	--	4
22507	Major Project-I (Cloud Computing or Big Data)	--	12	--	--	6#	--	6
	Total	**12**	**18**	**--**	**9**	**9**	**--**	**18**
Grand Total		**24**	**20**	**2**	**21**	**10**	**2**	**30**

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Pract & oral**	**Total**
		Internal Assessment			**End Sem. Exam**	**Exam. Duration (in Hrs)**			
		Test 1	**Test 2**	**Avg**					
General Education Component									
22501	Professional Skill-V (R-Programming)	10	10	10	40	2			50
22502	Management Information System	20	20	20	80	3	25	--	125
22503	Information Retrieval system	20	20	20	80	3	25	25	150
Skill Component									
22504	Machine Learning-1	20	20	20	80	3	25	25	150
22505	Cloud Network and Security	20	20	20	80	3	25	25	150
22506	Big data analytics	20	20	20	80	3	25	25	150
22507	Major Project-I (Cloud Computing or Big Data)	--	--	--	--	--	50#	--	50
Total		**--**	**--**	**110**	**440**	**--**	**175**	**100**	**825**

*Should be conducted batch wise and

$ indicates workload of Learner (Not Faculty), Students can form groups with minimum 2 (Two) and not more than 4 (Four), Faculty Load: 1 hour per week per four groups

# indicates practical and oral marks includes report and presentation

Program Structure for First Year Big Database and Cloud Computing

UNIVERSITY OF MUMBAI (With Effect from 2023-2024)
Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
General Education Component								
22601	Professional Skill-I (Cloud Computing using any one platform AWS, Azure, etc)	3	--	1*	3	--	1	4
22602	Environment Management	3	--	1*	3	--	1	4
22603	Internet of Things	3	2	--	3	1	--	4
	Total	**12**	**2**	**2**	**12**	**1**	**2**	**12**
Skill Component								
22604	Cyber Security	3	2	--	3	1	--	4
22605	Distributed Computing	3	2	--	3	1	--	4
22606	Machine Learning-II	3	2	--	3	1	--	4
22607	Major Project-II (Cloud Computing or Big Data)	--	12	--	--	6#	--	6
	Total	**12**	**18**	**--**	**9**	**9**	**--**	**18**
Grand Total		**24**	**20**	**2**	**21**	**10**	**2**	**30**

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Pract & oral**	**Total**
		Internal Assessment			**End Sem. Exam**	**Exam. Duration (in Hrs)**			
		Test 1	**Test 2**	**Avg**					
General Education Component									
22601	Professional Skill-I (Cloud Computing using any one platform AWS, Azure, etc)	10	10	10	40	2			50
22602	Environment Management	20	20	20	80	3	25	--	125
22603	Internet of Things	20	20	20	80	3	25	25	150
Skill Component									
22604	Cyber Security	20	20	20	80	3	25	25	150
22605	Distributed Computing	20	20	20	80	3	25	25	150
22606	Machine Learning-II	20	20	20	80	3	25	25	150
22607	Major Project-II (Cloud Computing or Big Data)	--	--	--	--	--	50#	--	50
Total		**--**	**--**	**110**	**440**	**--**	**175**	**100**	**825**

*Should be conducted batch wise and

# indicates practical and oral marks includes report and presentation

Course Code	Course Name	Credits
22101	Communication Skills	4

Course Objectives: The course aims :	
1	To demonstrate the fundamental concepts of communication.
2	To encourage active listening with focus.
3	To develop fluent speaking skills in social, academic and professional situations.
4	To train in reading strategies for comprehending academic and business correspondence.
5	To promote effective writing skills in business, technology and academic areas
6	To inculcate confident personality traits along with grooming and social etiquettes in technological society.
Course Outcomes: On successful completion, of course, learner/student will be able to:	
1	Learn & understand basics of communication
2	Develop four skills: listening , reading writing and speaking of language
3	Improve verbal ability in English both in terms of fluency and clarity.
4	Use effective reading skills for fast understanding of context
5	Develop academic , professional and technical writing Skills
6	Create an impressive content using ICT Tools

Module No.	Detailed Contents	Hrs
1	**Basics of Communication**	10
	Definition, Meaning & Concept, objectives of communication, Elements of communication, Process of communication, Barriers to communication Methods of communication (Verbal & Non- verbal) , Body language & gestures, Types of Listening	
2	**Spoken English & English language**	4
	i) Basic Grammar (ii) Noun, Pronoun, Adjective, Verb Tenses (iii) Preposition, Articles, Conjunction, Punctuation (iv) Vocabulary, (v) Spellings, (vi)Grammar, (vii) Sentence Structure, (viii) Synonyms, Antonyms, (ix) Sentence Construction (x) Introduction to everyday communication	
3	**Reading Skills**	

	Summarization and Comprehension: Passages to test the analytical skills and expression MCQ, Summary and introduction to graphic organizers.	4
4	**Writing Skills (Part-I)**	6
	• Picture Composition • Notice Writing • Memos • Letter writing • Technical Writing (Definition , Instruction . Process/ Procedure)	
5	**Digital Content Creation**	4
	Information Communication Technology (ICT) enabled Communication media: E-mail, Blog and Website.	

References:

1	Communication Skills Sanjay Kumar & Pushp Lata Oxford University Press.
2	Technical Communication: Principles and practice. Raman, M., & Sharma, S. Oxford University Press.
3	Communication Skills for Engineers Laxminarayanan K.R & Murugavel .T. Sitech Publication
4	Business Communication Raymond V Lesikar, Flately Marie E, Rentz Kathryn, Pande Neeraja McGraw- hill

Useful Links:

Sr. No.	URL
1	https://www.researchgate.net/publication/323794732_Barriers_to_Effective_Communication
2	https://nptel.ac.in/courses/109/104/109104031
4	https://www.academia.edu/42203605/Letter_Writing_PDF
5	https://intensiveintervention.org/sites/default/files/GraphicOrganizersPart4-508.pdf

Course Code	Course Name	Credits
22102	**Applied Mathematics**	**4**

Course Objectives: The course aims:	
1	To learn **the** concepts of Set theory and counting principles.
2	To understand the concept of Functions and define the recursive functions.
3	To understand the concept of vector spaces used in the field of engineering problems.
4	To understand the concept of linear independence of vectors over a field, and the dimension of a vector space.
5	To understand the concept of Singular value decomposition.
6	To understand the Matrix algebra engineering problems.
Course Outcomes: On successful completion, of course, learner/student will be able to:	
1	Apply the Set theory and counting principles.
2	Apply the Relation concepts and functions.
3	Apply the concept of vector spaces and orthogonalization process in Engineering Problems.
4	Use the concept of dimension in finding the rank of a matrix.
5	Using the concept of Singular value decomposition is a very useful tool in various Engineering applications.
6	Apply the concepts of eigenvalues and eigenvectors in engineering problems

Module	Detailed Contents		Hours
1	**Set theory**		8
	1.1	Definition of Sets, universal sets, subsets, Venn-Euler Diagrams, Operation on sets, complement of sets, De. Morgan's law.	
	1.2	Power set, Product of two or more sets, Equivalence relations, Partitions of sets with examples	
	1.3	Countable and Uncountable sets.	
	1.4	Counting principles: Pigeonhole principle, Principle of inclusion and exclusion, derangements.	
2	**Relation and Functions**		7
	2.1	Relation: Definition, types of relation, composition of relations, pictorial representation of relation (Digraphs), properties of relation, partial ordering relation. Operations on relations, and Closures.	

	2.2	Function: Definition and types of function, composition of functions, invertible functions. Recursive and recursively defined functions, Generating Functions.	
3	**Vectors**		8
	3.1	Vectors in n-dimensional vector space, norm, dot product, The Cauchy Schwarz inequality (without proof) and Unit vector.	
	3.2	Linear span of a set, linear combination, linear independent and dependent subsets.	
	3.3	Orthogonal projection, Orthonormal basis, Gram-Schmidt orthogonalization process for vectors.	
	3.4	Vector spaces over real field, and subspaces	
4	**Linear algebra-I**		8
	4.1	Basis: Coordinate systems, Basis, Unique representation, Change of basis and standard properties.	
	4.2	Dimension: Dimension and rank, column rank, and row rank	
	4.3	Linear transformations, properties, matrix of a linear transformation, change of basis, range and kernel.	
5	**Linear algebra-II**		7
	5.1	Singular Value Decomposition (SVD).	
	5.2	The adjoint of a linear operator.	
	5.3	Normal and Self adjoint operators.	
	5.4	Orthogonal projections and Spectral theorem.	
6	**Eigenvalues and Eigenvectors**		7
	6.1	Eigenvalues and Eigenvectors: Characteristic Polynomials of degree 2 and 3	
	6.2	Eigenvalues and eigenvectors, Properties of eigenvalues and eigenvectors,	
	6.3	Cayley–Hamilton Theorem (without proof), verification and reduction of higher degree polynomials.	
	6.4	Similarity of matrices, diagonalizable and non-diagonalizable matrices.	

References:	
1	Elements of Discrete Mathematics. L. Liu and D. P. Mohapatra, McGraw Hill
2	Linear algebra ,K. Hoffmann and R. A. Kunze, PHI Learning
3	Linear Algebra, Stephen H Friedberg, Eastern Economic Edition
4	Higher Engineering Mathematics, B.S. Grewal, Khanna Publishers
5	Elements of discrete Mathematics. L. Liu and D. P. Mohapatra, Tata McGraw-Hill.

Term Work:	
General Instructions:	
1	Batch wise tutorials have to be conducted. The number of students per batch will be as per University pattern for practical.
2	Students must be encouraged to write at least 6 class tutorials on the 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 will be considered as a mini project in Engineering Mathematics. This project will be graded out of 10 marks depending on the performance of the students.

Internal Assessment Test:	
The assessment consists of two class tests of 20 marks each. The 1stclass test (Internal Assessment I) has to be conducted when approximately 40% of the syllabus is completed. The 2nd class test has to be conducted (Internal Assessment II) when an additional 35% syllabus is Completed. The duration of each test will be for one hour.	
End Semester Theory Examination:	
1	The question paper will comprise a total of 6 questions, each carrying 20 marks.
2	Out of the 6 questions, 4 questions have to be attempted.
3	Question 1, based on the entire syllabus, will have 4sub-questions of 5 marks each and is compulsory.
4	Question 2 to Question 6 will have 3 sub-questions, each of 6, 6, and 8 marks, respectively.
5	Each sub-question in (4) will be from different modules of the syllabus.
6	Weightage of each module will be proportional to the number of lecture hours, as mentioned in the syllabus.

Useful Links	
1	https://nptel.ac.in/courses/111105123/
2	https://www.analyticsvidhya.com/blog/2017/02/lintroductory-guide-on-linear-programming-explained-in-simple-english/
3	https://u-aizu.ac.jp/~qf-zhao/AI/AI.html
4	Math for Machine Learning & AI (Artificial Intelligence) | Udemy
5	Vector Space - II - Vector Space | Coursera

Suggested List of Tutorials:

Sr. No.	**Topic**
1	Tutorial on Set theory
2	Tutorial on Principle of Inclusion and Exclusion
3	Tutorial on Pigeonhole Principle
4	Tutorial on Relation
5	Tutorial on Functions
6	Tutorial on system of linear algebraic equations

7	Tutorial on Caley Hamilton theorem
8	Tutorial on diagonalization of matrix
9	Tutorial on Gram-Schmidt orthogonalization
10	Tutorial on vector space and subspace
11	Tutorial on linear dependence and independence of vectors
12	Tutorial on basis and dimensions of vector space
13	Tutorial on linear transformation and its matrix
14	Tutorial on Singular Value Decomposition
15	Tutorial on normal, adjoint and self-adjoint operators

Course Code	Course Name	Credits
22103	**Object Oriented Programming – C++**	4

Pre-requisite: Basic Mathematics	
Course Objectives: The course aims:	
1	To understand the principles of Object Oriented Programming (OOP) language.
2	To understand object-oriented concepts such as data abstraction, encapsulation, inheritance and polymorphism.
3	To learn the object-oriented paradigm in program design.
4	To develop programming using OOP constructs
Course Outcomes: On successful completion, of course, learner/student will be able to:	
1	Describe the basic principles of OOP.
2	Apply OOP principles for classes and objects.
3	Develop programming applications using Inheritance.
4	Implement different programming applications using Polymorphism.
5	Analyze the strength of OOP using Exception handling.
6	Implement file handling operations of OOP.

Module	Detailed Contents		Hours
1	**Introduction to Object Oriented Language**		6
	1.1	Object Oriented Methodology: Introduction, Advantages and Disadvantages of Procedure Oriented Languages, what is Object Oriented? What is Object Oriented Development? Object Oriented Themes, Benefits and Application of OOPS. Principles of OOPS: OOPS Paradigm, Basic Concepts of OOPS: Objects, Classes, Data Abstraction and Data Encapsulation, Inheritance, Polymorphism, Dynamic Binding, Message Passing	
2	**Classes and Objects**		**6**
	2.1	Classes and Objects: Simple classes (Class specification, class members accessing), Defining member functions, passing object as an argument, Returning object from functions, friend classes, Pointer to object, Array of pointer to object	
	2.2	Constructors and Destructors: Introduction, Default Constructor, Parameterized Constructor and examples, Destructors	
3	**Inheritance**		**5**
	3.1	Program development using Inheritance: Introduction, understanding inheritance, Advantages provided by inheritance, choosing the access specifier, Derived class declaration, derived class constructors, class hierarchies, multiple inheritance, multilevel inheritance, containership, hybrid inheritance.	
4	**Polymorphism**		**6**
	4.1	Polymorphism: Concept of function overloading, overloaded operators, overloading unary and binary operators, overloading	

		comparison operator, overloading arithmetic assignment operator, Data Conversion between objects and basic types,	
	4.2	Virtual Functions: Introduction and need, Pure Virtual Functions, static Functions, this Pointer, abstract classes, virtual destructors	
5	**Exception Handling**		**8**
	5.1	Exception Handling: Introduction, Exception Handling Mechanism, Concept of throw & catch with example	
6	**File Handling**		**8**
		Templates: Introduction, Function Template and examples, Class Template and examples. Working with Files: Introduction, File Operations, Various File Modes, File Pointer and their Manipulation,	

Textbooks:	
1	**Let Us C++,** Yashavant Kanetkar, BPB publications
2	Object Oriented Programming with C++, E. Balagurusamy, Tata McGraw Hill
3	The C++ Programming language, Bjarne Stroustrup, Pearson Education
References:	
1	Effective Modern C++, Scott Meyers, SPD
2	Mastering C++, K R Venugopal, Rajkumar Buyya, T Ravishankar, Tata McGraw Hill
3	

Assessment:

Internal Assessment Test:

The assessment consists of two class tests of 20 marks each. The 1st class test (Internal Assessment I) has to be conducted when approximately 40% of the syllabus is completed. The 2nd class test has to be conducted (Internal Assessment II) when an additional 40% syllabus is completed. The duration of each test will be for one hour.

End Semester Theory Examination:

1	The question paper will comprise a total of 6 questions, each carrying 20 marks.
2	Out of the 6 questions, 4 questions have to be attempted.
3	Question 1, based on the entire syllabus, will have 4sub-questions of 5 marks each and is compulsory.
4	Question 2 to Question 6 will have 3 sub-questions, each of 6, 6, and 8 marks, respectively.
5	Each sub-question in (4) will be from different modules of the syllabus.
6	Weightage of each module will be proportional to the number of lecture hours, as mentioned in the syllabus.

Useful Links	
1	www.tutorialspoint.org, https://www.tutorialspoint.com/cplusplus/index.htm
2	www.javatpoint.com, https://www.javatpoint.com/cpp-tutorial,
3	www.w3schools.in, https://www.w3schools.com/cpp

Course Code	Course Name	Credit
22104	Data Structures and Algorithm	4

Course Objective: The course aims:	
1	To understand the need and significance of Data structures as a computer Professional.
2	To teach concept and implementation of linear and Nonlinear data structures.
3	To analyze various data structures and select the appropriate one to solve a specific real-world problem.
4	To introduce various techniques for representation of the data in the real world.
5	To teach various searching techniques.
Course Outcome: On successful completion, of course, learner/student will be able to:	
1	Implement Linear and Non-Linear data structures.
2	Handle various operations like searching, insertion, deletion and traversals on various data structures.
3	Explain various data structures, related terminologies and its types.
4	Choose appropriate data structure and apply it to solve problems in various domains.
5	Analyze and Implement appropriate searching techniques for a given problem.
6	Demonstrate the ability to analyze, design, apply and use data structures to solve engineering problems and evaluate their solutions

Module		Detailed Content	Hours
1		**Introduction to Data Structures**	**5**
	1.1	Introduction to Data Structures, Concept of ADT, Types of Data Structures-Linear and Nonlinear, Operations on Data Structures.	
2		**Stack and Queues**	**8**
	2.1	Introduction, ADT of Stack, Operations on Stack, Array Implementation of Stack, Applications of Stack-Well form-ness of Parenthesis, Infix to Postfix	
	2.2	Conversion and Postfix Evaluation, Recursion.	
	2.3	Introduction, ADT of Queue, Operations on Queue, Array Implementation of	
3		**Linked List**	**6**
	3.1	Introduction, Representation of Linked List, Linked List v/s Array, Types of Linked List - Singly Linked List, Circular Linked List, Doubly Linked List, Operations on Singly Linked List and Doubly Linked List, Stack and Queue using Singly Linked List, Singly Linked List Application-Polynomial Representation and Addition.	
4		**Trees**	**6**
	4.1	Introduction, Tree Terminologies, Binary Tree, Binary Tree Representation, Types of Binary Tree, Binary Tree Traversals, Binary Search Tree, Operations on Binary Search Tree, Applications of Binary Tree-Expression Tree, Huffman Encoding, Search Trees-AVL, rotations in AVL Tree, operations on AVL Tree, Introduction of B Tree, B+ Tree.	
5		**Graphs**	**6**
	5.1	Introduction, Graph Terminologies, Representation of Graph, Graph Traversals-	
	5.2	Depth First Search (DFS) and Breadth First Search (BFS), Graph Application-	
		Topological Sorting's	

6		**Searching Techniques**	
	6.1	Linear Search, Binary Search, Hashing-Concept, Hash Functions, Collision resolution Techniques	

Textbooks:	
1	**Data Structures Using C, "**Aaron M Tenenbaum, Yedidyah Langsam, Moshe J Augenstein," Pearson Publication.
2	Data Structures using C, "Reema Thareja" Oxford Press
3	Introduction to Data Structure and Its Applications, "Jean Paul Tremblay, P. G. Sorenson" McGraw-Hill Higher Education
4	Data Structure Using C, "E. Balagurusamy", Tata McGraw Hill
References:	
1	Andrew S. Tanenbaum, "Structured Computer Organization", Pearson Publication.
2	B. Govindarajalu, "Computer Architecture and Organization", McGraw-Hill Publication.
3	Malvino, "Digital computer Electronics", McGraw-Hill Publication, 3rdEdition.
4	Smruti Ranjan Sarangi, "Computer Organization and Architecture", McGraw-Hill Publication.

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of 6 questions, each carrying 20 marks.
2	The students need to solve total 4 questions.
3	Question No.1 will be compulsory and based on entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

Useful Links	
1	https://www.classcentral.com/course/swayam-computer-organization-and-architecture-a-pedagogical-aspect-9824
2	https://nptel.ac.in/courses/106/103/106103068/
3	https://www.coursera.org/learn/comparch
4	https://www.edx.org/learn/computer-architecture

Course Code	Course Name	Credits
22105	Computer Network	4

Course Objectives: The course aimed:	
1	To introduce concepts and fundamentals of data communication and computer networks.
2	To explore the inter-working of various layers of OSI.
3	To explore the issues and challenges of protocols design while delving into TCP/IP protocol suite.
4	To assess the strengths and weaknesses of various routing algorithms.
5	To understand various transport layer and application layer protocols.
Course Outcomes: On successful completion of course, learner will be able to **:**	
1	Demonstrate the concepts of data communication at physical layer and compare ISO - OSI model with TCP/IP model.
2	Explore different design issues at data link layer.
3	Design the network using IP addressing and sub netting / super netting schemes.
4	Analyze transport layer protocols and congestion control algorithms.
5	Explore protocols at application layer

Module	Detailed Contents		Hours
1	**The Intel Microprocessors 8086 Architecture**		8
	1.1	8086CPU Architecture,	
	1.2	Programmer's Model	
	1.3	Functional Pin Diagram	
	1.4	Memory Segmentation	
	1.5	Banking in 8086	
	1.6	Demultiplexing of Address/Data bus	
	1.7	Functioning of 8086 in Minimum mode and Maximum mode	
	1.8	Timing diagrams for Read and Write operations in minimum and maximum mode	
	1.9	Interrupt structure and its servicing	
2	**Instruction Set and Programming**		**6**
	2.1	Addressing Modes	
	2.2	Instruction set-Data Transfer Instructions, String Instructions, Logical Instructions, Arithmetic Instructions, Transfer of Control Instructions, Processor Control Instructions	
	2.3	Assembler Directives and Assembly Language Programming, Macros, Procedures	
3	**Memory and Peripherals interfacing**		**8**
	3.1	Memory Interfacing - RAM and ROM Decoding Techniques – Partial and Absolute	
	3.2	8255-PPI-Block diagram, CWR, operating modes, interfacing with 8086.	
	3.3	8257-DMAC-Block diagram, DMA operations and transfer modes.	
	3.4	Programmable Interrupt Controller 8259-Block Diagram, Interfacing the 8259 in single and cascaded mode.	
4	**Intel 80386DX Processor**		**7**
	4.1	Architecture of 80386 microprocessor	

	4.2	80386 registers–General purpose Registers, EFLAGS and Control	
		registers	
	4.3	Real mode, Protected mode, virtual 8086 mode	
	4.4	80386 memory management in Protected Mode – Descriptors and selectors, descriptor tables, the memory paging mechanism	
5	**Pentium Processor**		**6**
	5.1	Pentium Architecture	
	5.2	Superscalar Operation,	
	5.3	Integer &Floating-Point Pipeline Stages,	
	5.4	Branch Prediction Logic,	
	5.5	Cache Organization and	
	5.6	MESI protocol	
6	**Pentium 4**		**4**
	6.1	Comparative study of 8086, 80386, Pentium I, Pentium II and Pentium III	
	6.2	Pentium 4: Net burst micro architecture.	
	6.3	Instruction translation look aside buffer and branch prediction	
	6.4	Hyper threading technology and its use in Pentium 4	

Textbooks:	
1	John Uffenbeck, “8086/8088 family: Design Programming and Interfacing”, PHI.
2	Yu-Cheng Liu, Glenn A. Gibson, “Microcomputer System: The 8086/8088 Family, Architecture, Programming and Design”, Prentice Hall
3	Walter A. Triebel, “The 80386DX Microprocessor: hardware, Software and Interfacing”, Prentice Hall
4	Tom Shanley and Don Anderson, “Pentium Processor System Architecture”, Addison-Wesley.
5	K. M. Bhurchandani and A. K. Ray, “Advanced Microprocessors and Peripherals”, McGraw Hill
References:	
1	Barry B. Brey, “Intel Microprocessors”, 8thEdition, Pearson Education India
2	Douglas Hall, “Microprocessor and Interfacing”, Tata McGraw Hill.
3	Intel Manual
4	Peter Abel, “IBM PC Assembly language and Programming”, 5th Edition, PHI
5	James Antonakons, “The Pentium Microprocessor”, Pearson Education

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of 6 questions, each carrying 20 marks.
2	The students need to solve total 4 questions.
3	Question No.1 will be compulsory and based on entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

Useful Links	
1	https://swayam.gov.in/nd1_noc20_ee11/preview
2	https://nptel.ac.in/courses/108/105/108105102/
3	https://www.classcentral.com/course/swayam-microprocessors-and-microcontrollers-9894
4	https://www.mooc-list.com/tags/microprocessors

Course Code	Course Name	Credit
22106	Operating System	04

Course Objectives: The Course aimed:	
1	1. To introduce basic concepts and functions of operating systems.
2	2. To understand the concept of process, thread and resource management.
3	3. To understand the concepts of process synchronization and deadlock.
4	4. To understand various Memory, I/O and File management techniques.
Course Outcome: On successful completion of course, learner will be able to:	
1	Understand the objectives, functions and structure of OS
2	Analyze the concept of process management and evaluate performance of process scheduling Algorithms.
3	Understand and apply the concepts of synchronization and deadlocks
4	Evaluate performance of Memory allocation and replacement policies
5	Understand the concepts of file management.
	Apply concepts of I/O management and analyze techniques of disk scheduling.

Module	Detailed Content		Hours
1	**Operating system Overview**		**4**
	1.1	Introduction, Objectives, Functions and Evolution of Operating System	
	1.2	Operating system structures: Layered, Monolithic and Microkernel	
	1.3	Linux Kernel, Shell and System Calls	
2	**Process and Process Scheduling**		**9**
	2.1	Concept of a Process, Process States, Process Description, Process Control Block.	
	2.2	Uniprocessor Scheduling-Types: Preemptive and Non-preemptive scheduling algorithms (FCFS, SJF, SRTN, Priority, RR)	
	2.3	Threads: Definition and Types, Concept of Multithreading	
3	**Process Synchronization and Deadlocks**		**9**
	3.1	Concurrency: Principles of Concurrency, Inter-Process Communication, Process Synchronization.	
	3.2	Mutual Exclusion: Requirements, Hardware Support (TSL), Operating System Support (Semaphores), Producer and Consumer problem.	
	3.3	Principles of Deadlock: Conditions and Resource, Allocation Graphs, Deadlock Prevention, Deadlock Avoidance: Banker‟s Algorithm, Deadlock Detection and Recovery, Dining Philosophers Problem.	
4	**Memory Management**		**9**
	4.1	Memory Management Requirements, Memory Partitioning: Fixed, Partitioning, Dynamic Partitioning, Memory Allocation Strategies: Best-Fit, First Fit, Worst Fit, Paging and Segmentation, TLB	

	4.2	Virtual Memory: Demand Paging, Page Replacement Strategies: FIFO, Optimal, LRU, Thrashing	
5		**File Management**	**4**
	5.1	Overview, File Organization and Access, File Directories, File Sharing	
6		**I/O management**	**4**
	6.1	I/O devices, Organization of the I/O Function, Disk Organization, I/O Management and Disk Scheduling: FCFS, SSTF, SCAN, CSCAN, LOOK, C-LOOK.	

Textbooks:	
1	William Stallings, Operating System: Internals and Design Principles, Prentice Hall, 8thEdition, 2014, ISBN-10: 0133805913 • ISBN-13: 9780133805918.
2	Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, John Wiley &Sons, Inc., 9thEdition, 2016, ISBN 978-81-265-5427-0
References:	
1	Achyut Godbole and Atul Kahate, Operating Systems, McGraw Hill Education, 3rdEdition
2	Andrew Tannenbaum, Operating System Design and Implementation, Pearson, 3rdEdition.
3	Maurice J. Bach, “Design of UNIX Operating System”, PHI
4	Sumitabha Das, “UNIX: Concepts and Applications”, McGraw Hill, 4thEdition

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of 6 questions, each carrying 20 marks.
2	The students need to solve total 4 questions.
3	Question No.1 will be compulsory and based on entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules

Useful Links	
1	https://swayam.gov.in/nd1_noc19_cs50/preview
2	https://nptel.ac.in/courses/117/106/117106113/
3	https://www.classcentral.com/course/swayam-introduction-to-operating-systems-6559

Course Code	Lab Name	Credits
22103	Object oriented programming-C++ Lab	**1**

Suggested List of Practical/ Experiments:

Practical Number	Practical/ Experiment on C++ program:
1	Write a Program to design a class having a static member function named *showcount () which has the property of* displaying the number of objects created of the class.
2	Write a Program using class to process Shopping List for a Departmental Store. The list includes details such as the Code No and Price of each item and performs the operations like Adding, Deleting Items to the list and Printing the Total value of an Order.
3	Write a Program which creates & uses *array of object of a class. (For eg.* implementing the list of Managers of a Company having details such as Name, Age, etc...).
4	Write a Program to find Maximum out of Two Numbers using *Friend function.* *Note: Here one number is a member of one class and the other number is a member of some other class.*
5	Write a Program to swap private data members of classes named as *class_1, class_2* using friend function.
6	Write a Program to design a class complex to represent complex numbers. The complex class should use an external function (use it as a friend function) to add two complex numbers. The function should return an object of type complex representing the sum of two complex numbers.
7	Write a Program using a copy *constructor* to copy data of an object to another object.
8	Write a Program to allocate memory dynamically for an object of a given class using the class's constructor.
9	Write a Program to design a class to represent a matrix. The class should have the functionality to insert and retrieve the elements of the matrix.
10	Write a program to design a class representing complex numbers and having the functionality of performing addition & multiplication of two complex numbers using operator overloading.
11	Write a program for developing a matrix class which can handle integer matrices of different dimensions. Also overload the operator for addition, multiplication & comparison of matrices.
12	Write a C++ program to use pointers for both base and derived classes and call the member function. Use Virtual keyword

Course Code	Lab Name	Credits
22104	**Data Structure and Algorithms Lab**	**1**

Suggested List of Practical/ Experiments:

Practical Number	Practical/ Experiment
1	Implement Stack ADT using an array.
2	Convert an Infix expression to Postfix expression using stack ADT.
3	Evaluate Postfix Expression using Stack ADT.
4	Applications of Stack ADT.
5	Implement Linear Queue ADT using an array.
6	Implement Circular Queue ADT using an array.
7	Implement Priority Queue ADT using array.
8	Implement Stack / Linear Queue ADT using Linked List.
9	Implement Binary Search Tree ADT using Linked List.
10	Implement Graph Traversal techniques :) Depth First Search b) Breadth First Search

Lab Code	Lab Name	Credits
22105	**Computer Network Lab**	**1**

Suggested List of Practical/ Experiments:

Sr. No.	Title of Experiment
1.	Study of RJ45 and CAT6 Cabling and connection using crimping tool.
2.	Use basic networking commands in Linux (ping, tracert, nslookup, netstat, ARP, RARP, ip, ifconfig, dig, route)
3.	Build a simple network topology and configure it for static routing protocol using packet tracer. Setup a network and configure IP addressing, subnetting, masking.
4.	Perform network discovery using discovery tools (eg. Nmap, mrtg)
5.	Use Wire shark to understand the operation of TCP/IP layers: ● Ethernet Layer: Frame header, Frame size etc. ● Data Link Layer: MAC address, ARP (IP and MAC address binding) ● Network Layer: IP Packet (header, fragmentation), ICMP (Query and Echo) ● Transport Layer: TCP Ports, TCP handshake segments etc. ● Application Layer: DHCP, FTP, HTTP header formats

6.	Use simulator (Eg. NS2) to understand functioning of ALOHA, CSMA/CD.
7.	Study and Installation of Network Simulator (NS3)
8.	a. Set up multiple IP addresses on a single LAN. b. Using nestat and route commands of Linux, do the following: ● View current routing table ● Add and delete routes ● Change default gateway c. Perform packet filtering by enabling IP forwarding using IPtables in Linux.
9	Design VPN and Configure RIP/OSPF using Packet tracer.
10.	Socket programming using TCP or UDP
11.	Perform File Transfer and Access using FTP
12.	Perform Remote login using Telnet server

Course Code	Course Name	Credit
22106	**Operating System Lab**	**01**

Suggested List of Practical/ Experiments:

Sr. No.		Content
1		**Explore Linux Commands**
	1.1	**Explore usage of basic Linux Commands and system calls for file, directory and process management.** For eg: (mkdir, chdir, cat, ls, chown, chmod, chgrp, ps etc. System calls: open, read, write, close, getpid, setpid, getuid, getgid, getegid, geteuid. Sort, grep, awk, etc.)
2		**Linux shell script**
	2.1	Write shell scripts to do the following: a. Display OS version, release number, kernel version b. Display top 10 processes in descending order c. Display processes with highest memory usage. d. Display current logged in user and log name. Display current shell, home directory, operating system type, current path setting, current working directory.
3		**Linux- API**
	3.1	Implement any one basic commands of linux like ls, cp, mv and others using kernel APIs.
4		**Linux- Process**
	4.1	a. Create a child process in Linux using the fork system call. From the child process obtain the process ID of both child and parent by using getpid and getppid system call. b. Explore wait and waitpid before termination of process.
5		**Process Management: Scheduling**

	5.1	a. Write a program to demonstrate the concept of non-preemptive scheduling algorithms. b. Write a program to demonstrate the concept of preemptive scheduling algorithms
6		**Process Management: Synchronization**
	6.1	**a.** Write a C program to implement solution of Producer consumer problem through Semaphore
7		**Process Management: Deadlock**
	7.1	a. Write a program to demonstrate the concept of deadlock avoidance through Banker's Algorithm b. Write a program demonstrate the concept of Dining Philosopher's Problem
8		**Memory Management**
	8.1	a. Write a program to demonstrate the concept of MVT and MFT memory management techniques b. Write a program to demonstrate the concept of dynamic partitioning placement algorithms i.e. Best Fit, First Fit, Worst-Fit etc.
9		**Memory Management: Virtual Memory**
	9.1	a. Write a program to demonstrate the concept of demand paging for simulation of Virtual Memory implementation b. Write a program in C demonstrate the concept of page replacement policies for handling page faults eg: FIFO, LRU etc.
10		**File Management & I/O Management**
	10.1	a. Write a C program to simulate File allocation strategies typically sequential, indexed and linked files b. Write a C program to simulate file organization of multi-level directory structure. c. Write a program in C to do disk scheduling - FCFS, SCAN, C-SCAN

Course Code	Course Name	Credits
22201	**Business communication Ethics**	**4**

Course Objectives: The course aimed:	
1	To enhance effective communication and interpersonal skills
2	To explain / defend his/her ideas to a single person or panel.
3	To develop creative and impactful presentation skills.
4	To understand the dynamics of business communication through group communication. required for career enhancement.
5	To develop analytical and logical skills for problem-solving.
Course Outcomes: On successful completion, of course, learner/student will be able to:	
1	Prepare effective business/ technical documents apt for managerial roles in social and professional situations.
2	Deliver effective business and technical presentations.
3	Develop life skills/interpersonal skills to build a confident personality.
4	Develop creative thinking and problem solving attitude through group communication
5	Organize personal and professional skills to build an impressive professional image for internal or external communication.
6	Apply the trait of a successful professional with a charismatic personality.

Module	Detailed Contents		Hours
1	**Writing Skills (Part -II) A Report & Proposal Writing**		7
	1.1	Report Writing : Objectives of Report Writing (on General Topics) Language and Style in a report	
	1.2	Types: Informative and Interpretative (Analytical, Survey and Feasibility) and Formats of reports(Short Report)	
	1.3	Proposal Writing :Short Proposal Writing : Objectives, formats, language style	
2	**Writing Skills (Part -II) B Business/ Trade Letters**		7
	2.1	Order credit and status Enquiry Letters of inquiry, letter of complaints, Claim & adjustment letter Sales Letter, promotional leaflets and fliers	
3	**Presentation Skills**		5
	3.1	Technical Presentation Business Presentation *n*	
4	**Introduction to Interpersonal Skills**		7
	4.1	Emotional Intelligence,Leadership and Motivation,Team Building,Assertiveness Conflict Resolution and Negotiation Skills,Time Management,Decision Making	

5	**Meetings and Documentation**		6
	5.1	Need & Importance of meeting , Conduct of meeting ,Strategies for conducting effective meetings,Notice, Agenda and Minutes of a meeting, Business meeting etiquettes	
6	**Introduction to Business Ethics**		7
	6.1	Concept & meaning, Importance of Business Ethics, Business Ethics & Media Computer Ethics, personal integrity at public place	

Books and References:

Sr. No	Publisher
1	Business communication today. Bovée, C. L., & Thill, J. V. NJ: Pearson.
2	Place Mentor, Tests of Aptitude for Placement Readiness. RamArchana Oxford University Press
3	Technical Communication, Principles and Practice. Raman Meenakshi, Sharma Sangeeta Oxford University Press
4	Personal development for life and work. Masters, L. A., Wallace, H. R., & Harwood, L. Mason: South-Western Cengage Learning.

Term Work:		
General Instructions:		
1	Batch wise tutorial shave to be conducted. The number of students per batch will be as per University pattern for practical.	
2	Students must be encouraged to write at least 6 class tutorials on the 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 will be considered as a mini project in Engineering Mathematics. This project will be graded out of 10 marks depending on the performance of the students.	
The distribution of Term Work marks will be as follows:		
1	Attendance (Theory and Tutorial)	05 marks
2	Class Tutorials on entire syllabus	10 marks
3	Mini project	10 marks

Assessment:
Internal Assessment Test:

The assessment consists of two class tests of 20 marks each. The 1stclass test (Internal Assessment I) has to be conducted when approximately 40% of the syllabus is completed. The 2nd class test has to be conducted (Internal Assessment II) when an additional 35% syllabus is completed. The duration of each test will be for one hour.

End Semester Theory Examination:	
1	The question paper will comprise a total of 6 questions, each carrying 20 marks.
2	Out of the 6 questions, 4 questions have to be attempted.
3	Question 1, based on the entire syllabus, will have 4sub-questions of 5 marks each and is compulsory.
4	Question 2 to Question 6 will have 3 sub-questions, each of 6, 6, and 8 marks, respectively.
5	Each sub-question in (4) will be from different modules of the syllabus.
6	Weightage of each module will be proportional to the number of lecture hours, as mentioned in the syllabus.

Suggested List of Tutorials:

Sr. No	Topic
1	Report writing Or Proposal Writing (Brief reports on general topics)
2	Letter writing
3	Business Or Technical presentation
4	Public Speaking Activity
5	Role Play & Model Building
6	Meetings Documentation (Notice agenda & minutes writing
7	Case study on business/ corporate ethics
8	Group discussion & Debate

Course Code	Course Name	Credit
22202	**Probability And Statistics**	3

Course Objectives: The Course aimed:

1. To understand some advanced topics of probability, random variables with their expectations and variances.
2. To make the learner able to use different measures of central tendency and dispersion wherever relevant and check the Skewness and Kurtosis of data.
3. To make the learner able to apply the concepts of probability distributions.
4. To make the learner able to apply the concepts of sampling theory for large samples.
5. To make the learner able to apply the concepts of sampling theory for small samples
6. To make learners able to find the correlation between different variables and further apply the regression analysis to find the exact relation between them.

Learning Outcomes:

After successful completion of this course, learners would be able to

1. Understand the concepts of probability and expectation for getting the spread of the data.
2. Analyze Statistical data using measures of central tendency and dispersion.
3. Understand the concepts of distribution of probabilities.
4. Use the concept of sampling theory on large samples.
5. Use the concept of sampling theory on small samples.
6. Apply the concept of Correlation and Regression to the problems in data science, machine learning, and AI.

Module No	Topics	No of Lectures
1	1.1 Definition and basics of probability, Space and Events, conditional probability. 1.2 Total Probability theorem and Bayes' theorem. 1.3 Discrete and continuous random variable with probability distribution and probability density function. 1.4 Expectation and Variance.	9
2	2.1 Measures dispersion: Concept of dispersion, Absolute and Relative, Quartile deviation, Standard deviation, Combined standard deviation. Coefficient of range, Coefficient of quartile deviation and Coefficient of variation (C.V.) 2.2 Moments: Concept of Moments, Raw moments, Central moments, Relation between raw and central moments. 2.3 Measures of Skewness and Kurtosis: Concept of Skewness and Kurtosis, measures based on moments, quartiles.	8
3	3.1 Binomial Distribution, Poisson Distribution and Normal Distribution 3.2 Evaluation of statistical parameters for these three distributions (Distribution functions, Mean and Variance).	8

4	4.1 Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom. Standard Normal Variate, Central Limit Theorem, standard error, Type-I and Type-II errors, estimation, confidence intervals 4.2 Large sample test for single mean, difference of means, and difference of standard deviations.	9
5	5.1 Students'-distribution (Small sample) - Test the significance of mean and difference between the means of two samples. 5.2 Chi-Square Test: Test of goodness of fit and independence of attributes, Contingency table and Yates's correction. 5.3 Analysis of variance: F-test (significant difference between variances of two samples)	9
6	6.1 Measure of Correlation: Scatter diagram and interpretation, Karl Pearson's coefficient of correlation (r) 6.2 Spearman's Rank correlation coefficient (R) (with repeated and Non- repeated ranks). Relation between correlation and regression. 6.3 Lines of regression and multivariable regression. 6.4 Fitting of first- and second-degree curves.	9

Books and References:

1	Fundamentals of Mathematical Statistics, S.C. Gupta & V.K. Kapoor Sultan Chand & CO.
2	Introduction to Probability Theory, G. Hoel, S. C. Port and C. J. Stone Universal BookStall
3	An Introduction to Statistical Learning: with Applications in R by Gareth James, Daniela Witten, Trevor Hastie Springer
4	A textbook of Engineering Mathematics, N.P. Bali and Manish Goyal Laxmi Publications
5	Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill Education

Useful Links
https://nptel.ac.in/courses/111/106/111106112/
https://nptel.ac.in/courses/111/105/111105124/
https://www.youtube.com/watch?v=L-pQtGm3VS8 https://www.youtube.com/watch?v=vN5cNN2-HWE

List of Tutorials:

Sr. No.	Topic
1	Tutorial on Conditional Probability and Bayes theorem
2	Tutorial on discrete and continuous random variables
3	Tutorial on Central Tendency: Mean, Median, Mode
4	Tutorial on Correlation
5	Tutorial on Regression
6	Tutorial on Curve fitting
7	Tutorial on Sampling theory
8	Tutorial on large sample test for single mean and difference of means
9	Tutorial on large sample test for difference of standard deviations
10	Tutorial on small sample test for single mean and difference of means
11	Tutorial on large sample test for difference of standard deviations
12	Tutorial on Chi-Square Test
13	Tutorial on F-test

Course Code:	Course Title	Credit
22203	Introduction to Data Science	4

Course Objectives: The course aimed:

1. To build the fundamentals of data science.
2. To build a classification model and interpret results
3. To learn the intricacies of logistic regression, evaluate its outputs, and comprehend how a link function works
4. To handle a data set to produce a specified set of results

Course Outcome:

On successful completion, of course, learner/student will be able to:

1. To be able to calculate probabilities for continuous and discrete random variables.
2. To understand the basics of statistics.
3. To understand Bivariate statistics
4. To understand theory of sampling
5. To understand Test of significance
6. To understand Paired test, chi-square test for goodness of fit.

Module No.	Detailed Contents	Hrs
1	**Basic Probability** Probability spaces, conditional probability, independence, Bayes theorem, Discrete random variables, Independent random variables, sums of independent random variables; Expectation of Discrete and Continuous Random Variables, Moments, Variance of a sum	8
2	**Basic Statistics**	8
	Measures of Central tendency, Moments, skewness and Kurtosis, Binomial, Poisson and Normal distribution and evaluation of statistical parameters for these three distributions (Distribution functions, Mean and Variance).	
3	**Bivariate Statistics**	10
	Correlation and Regression – Concepts of Correlation, Coefficient of Correlation, Rank correlation, Regression Analysis - linear & multivariable regression, Curve fitting by the method of least squares- fitting of straight lines, second degree polynomials	
4	**Sampling Theory**	7

	Introduction to sampling distributions, Standard Normal Variate, Central Limit Theorem, standard error, Type-I and Type-II errors, estimation, confidence intervals	
5	**Applied Statistics -I**	8
	Test of significance: Large sample test for single mean, difference of means, and difference of standard deviations, Small samples test for single mean, difference of means	
6	**Applied Statistics – II**	5
	Paired t-test, Chi-square test for goodness of fit and independence of attributes, Test for ratio of variances	

Books and References:

1	Fundamentals of Mathematical Statistics, S.C. Gupta & V.K. Kapoor, Sultan Chand & Co
2	Introduction to Probability Theory, P. G. Hoel, S. C. Port and C. J. Stone, Universal BookStall
3	An Introduction to Statistical Learning: with Applications in R, Gareth, James, Daniela Witten, Trevor Hastie, Springer
4	A First Course in Probability, S. Ross, Pearson Education India

Useful Links:

Sr.No.	URL
1	https://www.statisticssolutions.com/continuous-probability-distribution/
2	https://nptel.ac.in/courses/111106112
3	https://nptel.ac.in/courses/111105124
4	https://www.youtube.com/watch?v=L-pQtGm3VS8 https://www.youtube.com/watch?v=vN5cNN2-HWE

Course Code:	**Course Title**	**Credit**

22204	ADVANCED OPERATING SYSTEMS	04

Course Objectives: The course aimed:

1. To understand the Operating System & their functions.
2. To understand the working of a distributed Operating System.
3. To study various Operating System as Microprocessor , RTOS , database , Mobile.

Course Outcome:

On successful completion, of course, learner/student will be able to:

1. Learn functions of operating system.
2. Understand distributed operating systems and their architecture.
3. Student will implement scheduling algorithm of microprocessor operating systems.
4. Understand Real time operating systems and various algorithm.
5. Understand Database operating systems and various algorithm.
6. Understand the implementation of mobile operating system on android platform.

Module	Detailed content	Hours
1	**Introduction** Functions of operating systems, Design approaches: layered ,kernel based and virtual machine approach, why advanced operating systems, types of advanced operating systems	4
2	**Distributed Operating Systems** Architecture of distributed operating systems, system architecture types, issues in distributed operating systems, inherent limitation of distribute systems, distributed mutual exclusion: classification of mutual exclusion algorithms, Lamport's ,token based algorithm, Suzuki-Kasami's Broadcast algorithm, Raymond's Tree based algorithm, Distributed deadlock detection, Distributed file systems, Distributed shared memory, Distributed scheduling	8
3	**Multiprocessor Operating Systems** Introduction, structure of multiprocessor operating system, operating system design issues, threads, the test and set instruction, the swap instruction, implementation of the process wait, processor scheduling, reliability and fault tolerance.	6
4	**Real Time Operating System** Introduction to Real time systems and Real Time Operating Systems, Characteristics of Real Time operating Systems, Classification of Real Time Operating Systems, Services, structure, goal and feature of RTOS, architecture of RTOS, micro kernels and monolithic kernels, tasks in RTOS, Performance measures, estimating program runtimes, task assignment, scheduling in RTOS, rate monotonic scheduling, priority inversion, task management, inter task communication, applications of various RTOS.	10
5	**Database operating Systems** Introduction to database operating systems, concurrency control: theoretical aspect, distributed database system, concurrency control algorithms	6

6	**Mobile Operating System** Symbian O.S.: introduction, kernel design in Symbian OS, scheduling in Symbian OS, File systems on mobile phones, I/O in Symbian OS, Application development using Android. Introduction to cloud OS.	6

Books and References:

1	M Singhal and NG Sivaratri, Advanced Concepts in Operating Systems, Tata McGraw Hill Inc., 2001
2	A.S. Tanenbaum, Distributed Operating system, Pearson Education Asia, 2001.
3	A.S. Tanenbaum, Modern Operating system, Prentice Hall, 3rd edition.
4	Real Time Operating System, Barr M.
5	Real-Time Systems, Jane Liu, Pearson Ed. Asia
6	Real -Time Systems, Krishna and Shin, McGraw Hill International.
7	Smart phone operating system concepts with Symbian O.S. A tutorial guide by Michael J.Jipping. Symbian Press, Wiley.
8	Application development using Android, Hello, Android, mobile development platform 3rd Edition by Ed Burnette
9	SILBERSCHATZ and P. GALVIN, Operating System Concepts, VI **edition**, Addison Wesley 2004.

SUGGESTED LABORATORY EXERCISES:

Case studies on Open source software, LINUX, Open SOLARIS, PalmOS, Symbian OS, Mach OS, Android OS, Linux For Mobile Devices, various RTOS.

Course Code	Course Name	Credit
22205	**Introduction to Cloud Computing**	**4**

Course Objectives: The course aimed:	
1	To Understand the fundamentals of cloud computing
2	To Understand the concept of Cloud models
3	To introduce various types of cloud services
4	To Appreciate the importance of virtualization of cloud
5	To understand security aspects of cloud
6	To understand advances of cloud computing
Course Outcomes: On successful completion, of course, learner/student will be able to:	
1	Explain fundamentals of cloud computing
2	Explain the concept of various cloud models
3	Interpret various cloud computing services
4	Interpret the significance of virtualization in the context of cloud
5	Interpret security aspects of cloud
6	Explain advances in cloud computing in terms of multimedia, Fog and Edge computing and their applications in the real world

Module No.	Detailed Contents	
1	**Introduction to Cloud Computing** Evolution of cloud, Essentials, Cloud Computing definition, Benefits and Challenges, Limitations, Usage and Applications, Business Models around Cloud Computing, Characteristics, Cloud Adoption	6
2	**Cloud models** Introduction, Collaboration to cloud, Cloud Models, Cloud Applications and Architecture, Cloud Computing Architecture, Cloud Infrastructure Models, Cloud Infrastructure Self Service, Scaling a cloud infrastructure	10
3	**Cloud services** Introduction to Services, Storage as a Service, Database as a Service, Information as Service, Process as a Service, Application as a Service, Management/Governance as Service, Platform as a Service, Security as a Service, Testing as Service, Integration as Service, Infrastructure as Service	10
4	**Virtualization for cloud** Introduction, Pros and Cons of Virtualization, Virtualization Architecture, Virtualization Machine, Virtualization in Clusters/Grid Context, Virtual Network, Types of Virtualization, Virtual Machine Monitor, Virtual Desktop Infrastructure	7
5	**Cloud security** Host security for Saas,Iaas and Paas , Data Security, Data confidentiality and Encryption – Data Availability- Data integrity, Cloud storage gateway, Cloud Firewall. AAA model, SSO model for cloud, Authentication, Authorization and Accounting for cloud.	6

6	**Cloud Application** Cloud computing application: Cloud computing for healthcare, Education, transportation, Manufacturing. Multimedia Cloud- Streaming protocols Case studies- Fog computing, Edge computing, Video streaming app and video Transcoding app.	6

Books & References:

1	Cloud Computing - A Hands-on Approach Arshdeep Bahga and Vijay K. Madisetti Universities Press
2	Mastering Cloud Computing: Foundations and Applications Programming, Rajkumar Buyya, Christian, Vecchiola. S.Thamarai Selvi, Morgan Kaufmann
3	Amazon Web Services For Dummies, Bernard Golden, John Wiley & Sons
4	The Cloud Computing Book: The Future of Computing Explained, Douglas E. Comer, Taylor and Francis group
5	Cloud Computing Black Book, Kailash Jayaswal, Jagannath Kallakurchi. Donald J. Houde. Dr. Deven Shah, Dreamtech Press

Useful Links

1	https://.aws.amazon.com/whitepapers/
2	https://azuremicrosoft.com/en-in/resources/whitepapers
3	https://cloud.google.com/whitepaper

Course Code:	Course Title	Credit
22206	Software Engineering	4

Course Objectives: The course aimed:	
1	To provide the knowledge of software engineering discipline.
2	To apply analysis, design and testing principles to software project development.
3	To demonstrate and evaluate real world software projects.
Course Outcomes: On successful completion, of course, learner/student will be able to:	
1	Identify requirements & assess the process models.
2	Plan, schedule and track the progress of the projects.
3	Design the software projects.
4	Do testing of software project.
5	Identify risks, manage the change to assure quality in software projects.

Module		Detailed Content	Hrs
1		**Introduction To Software Engineering and Process Models**	**7**
	1.1	Software Engineering-process framework, the Capability Maturity Model(CMM), Advanced Trends in Software Engineering	
	1.2	Prescriptive Process Models: The Waterfall, Incremental Process Models, Evolutionary Process Models: RAD & Spiral	
	1.3	Agile process model: Extreme Programming (XP), Scrum, Kanban	
2		**Software Requirements Analysis and Modeling**	**4**
	2.1	Requirement Engineering, Requirement Modeling, Data flow diagram,Scenario based model	
	2.2	Software Requirement Specification document format(IEEE)	
3		**Software Estimation Metrics**	**7**
	3.1	Software Metrics, Software Project Estimation (LOC, FP, COCOMO II)	
	3.2	Project Scheduling & Tracking	
4		**Software Design**	**7**
	4.1	Design Principles & Concepts	
	4.2	Effective Modular Design, Cohesion and Coupling, Architectural design	
5		**Software Testing**	**7**
	5.1	Unit testing, Integration testing,Validation testing, System testing	
	5.2	Testing Techniques, white-box testing: Basis path, Control structure testingblack-box testing: Graph based, Equivalence, Boundary Value	
	5.3	Types of Software Maintenance, Re-Engineering, Reverse Engineering	
6		**Software Configuration Management, Quality Assurance andMaintenance**	**7**
	6.1	Risk Analysis & Management: Risk Mitigation, Monitoring andManagement Plan (RMMM).	
	6.2	Quality Concepts and Software Quality assurance Metrics, Formal TechnicalReviews, Software Reliability	
	6.3	The Software Configuration Management (SCM) ,Version Control and Change Control	
Books & References			

1	Roger Pressman, "***Software Engineering: A Practitioner's Approach"***, 9th edition , McGraw-Hill Publications, 2019
2	Ian Sommerville, ***"Software Engineering"***, 9th edition, Pearson Education, 2011
3	Ali Behfrooz and Fredeick J. Hudson, ***"Software Engineering Fundamentals"***, Oxford University Press, 1997
4	Grady Booch, James Rambaugh, Ivar Jacobson, ***"The unified modeling language user guide"***, 2nd edition, Pearson Education, 2005
5	Pankaj Jalote, ***"An integrated approach to Software Engineering"***, 3rd edition, Springer, 2005
6	Rajib Mall, ***"Fundamentals of Software Engineering"***, 5th edition, Prentice Hall India, 2014
7	Jibitesh Mishra and Ashok Mohanty, ***"Software Engineering"***, Pearson , 2011
8	Ugrasen Suman, ***"Software Engineering – Concepts and Practices"***, Cengage Learning, 2013
9	Waman S Jawadekar, ***"Software Engineering principles and practice"***, McGraw Hill Education, 2004

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and the second-class test when an additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Only Four questions need to be solved.
4	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Useful Links	
1	https://nptel.ac.in/courses/106/105/106105182/
2	https://onlinecourses.nptel.ac.in/noc19_cs69/preview
3	https://www.mooc-list.com/course/software-engineering-introduction-edx

Lab Code	Lab Name	Credit
22203	**Introduction to Data Science Lab**	**1**

Suggested List of Practical/ Experiments:

Practical Number	Practical/ Experiment Topic
1	Implement conditional probability and Bayes theorem
2	Perform experiment to plot probabilities for continuous and discrete random variable
3	Perform experiment to measure central tendency of a dataset
4	Perform experiment to measure dispersion of a dataset
5	Perform experiment to calculate correlation between variables
6	Implement Regression
7	Implement curve fitting optimization using SciPy package
8	Implement Sampling distributions
9	Implement Statistical Significance tests
10	1. Statistical analysis of Criminal offenses 1999- 2007 2. Regression analysis on National income 1998- 2003 3. Statistical analysis of student expenditure 4. Infant Mortality rate analysis 1995-2004 5. Cash deposit pattern analysis in commercial banks 6. Analysis of coal 7. Financial statement analysis to aid meaningful investment decision making 8. Cluster analysis on effect of dollar increment on economy 9. Regression analysis on hours spent on internet and time spent to study on academic performance of students

Course Code	Course Name	Credit
22204	Advanced Operating System Lab	01

Suggested List of Practical/ Experiments:

Sr. No.	Content
1	Atleast one Experiment using Unix commands
2	Experiment using linux shell script
3	Experiment based on Distributed scheduling algorithm
4	Experiment based on Distributed operating system
5	Experiment based on Mobile operating system

Lab Code	Lab Name	Credit
22205	Introduction to Cloud Computing Lab	**1**

Suggested List of Practical/ Experiments:-

Practical Number	Practical/ Experiment
1	Study and implementation of infrastructure as a service
2	Installation and Configuration of virtual machine
3	Study and implementation of Storage as a Service
4	Study and implementation of identity management
5	Study Cloud Security management
6	Write a program for web feed
7	Study and implementation of Single-Sign-On
8	Case study on Amazon EC2/Microsoft Azure/Google Cloud Platform

Lab Code	Lab Name	Credit
22206	**Software Engineering Lab**	**1**

Suggested List of Experiments - Assign the case study/project as detail statement of problem to a group of two/three students. Laboratory work will be based on course syllabus with minimum 10 experiments. Open source computer-aided software engineering (CASE) tools can be used for performing the experiment.	
Sr. No.	**Title of Experiment**
1	Application of at least two traditional process models.
2	Application of the Agile process models.
3	Preparation of software requirement specification (SRS) document in IEEE format.
4	Structured data flow analysis.
5	Use of metrics to estimate the cost.
6	Scheduling & tracking of the project.
7	Write test cases for black box testing.
8	Write test cases for white box testing.
9	Preparation of Risk Mitigation, Monitoring and Management Plan (RMMM).
10	Version controlling of the project.

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of "Software Engineering"
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus of CSC502 and CSL501 syllabus

Semester III

Course Code:	Course Title	Credit
22301	Professional Skill-III (Entrepreneurship)	4

Prerequisite: Business Communication Ethics	
Course Objectives:	
1	To provide a detailed overview of entrepreneurship as the foundation of business growth
2	To teach to adopt entrepreneurship as value creation in the national economy.
3	It provides multiple constructs for entrepreneurs to be successful.
4	It provides multiple pathways for their companies to achieve sustainable growth.
Course Outcomes:	
1	To understand key concepts underpinning entrepreneurship
2	To apply knowledge in the recognition and exploitation of product/ service/ process opportunities
3	To demonstrate key concepts underpinning innovation and the issues associated with developing and sustaining innovation within organizations
4	To understand, how to design creative strategies for pursuing, exploiting and further developing new opportunities
5	To understand Issues associated with securing and managing financial resources in new and established organizations.

Module		Content	Hrs
1		**Introduction to Entrepreneurial Journey**	**8**
	1.1	Entrepreneurial Journey	
	1.2	Entrepreneurial Discovery	
2		**Ideation and Prototyping**	**8**
	2.1	Ideation and Prototyping.	
	2.2	Testing, Validation and Commercialization, Disruption as a Success Driver	
3		**Technological Innovation and Entrepreneurship**	**8**
	3.1	Technological Innovation and Entrepreneurship – 1	
	3.2	Technological Innovation and Entrepreneurship – 2 ,Raising Financial Resources	
4		**Education and Entrepreneurship**	**7**
	4.1	Education and Entrepreneurship.	
	4.2	Beyond Founders and Founder-Families, India as a Start-up Nation	
5		**National Entrepreneurial Culture**	**7**
	5.1	National Entrepreneurial Culture.	

	5.2	Entrepreneurial Thermodynamics, Entrepreneurship and Employment.	
6		**Start-up Case Studies.**	**7**
	6.1	Discuss at least five case studies.	
		Total	**45**

Textbooks:	
1	Peter Thiel "Zero to One: Notes on Startups, or How to Build the Future", Crown, 16 Sept 2014 - Business & Economics - 224 pages.
2	Eric Ries "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses" published January 1, 2011, Board Book

Referecebooks:	
1	C B Rao "India as Global Start-up Hub: Mission with Passion" Notion Press, 2018,
2	Ashlee Vance ,"Elon Musk: Tesla, SpaceX, and the Quest for a Fantastic Future", Ecco Press, Publish Year: 2015
3	Walter Isaacson "Steve Jobs", October 1, 2011

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 10 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Useful Links	
1	https://onlinecourses.nptel.ac.in/noc20_mg35/preview.
2	https://www.business-school.ed.ac.uk/msc/entrepreneurship-innovation/overview/learning-outcomes

List of Tutorial:

Tutorial Number	**Tutorial Topic**
1	Field study of Industries offices in vicinity.
2	Visit to Atal incubation Center.
3	Create Business Model on any project.

Course Code	Course Name	Credits
22302	Computer Organization and Architectures	4

Course Objectives: The course aims:	
1	To conceptualize the basics of organizational and architectural issues of a digital computer.
2	To analyze performance issues in processor and memory design of a digital computer.
3	To understand various data transfer techniques in digital computer.
4	To analyze processor performance improvement using instruction level parallelism.
Course Outcomes: On successful completion, of course, learner/student will be able to:	
1	To understand basic structure of computer.
2	To perform computer arithmetic operations.
3	To understand control unit operations.
4	To design memory organization that uses banks for different word size operations.
5	To understand the concept of cache mapping techniques.

Module	Detailed Contents		Hours
1	**Overview of Computer Architecture & Organization**		8
	1.1	Introduction of Computer Organization and Architecture.	
	1.2	Basic organization of computer and block level description of the functional units, Evolution of Computers, Von Neumann model.	
	1.3	Performance measure of Computer Architecture.	
	1.4	Introduction to buses and connecting I/O devices to CPU and Memory, bus structure	
2	**Data Representation and Arithmetic Algorithms:**		7
	2.1	Number representation: Binary Data representation, two's complement representation and Floating-point representation. IEEE 754 floating point number representation	
	2.2	Integer Data computation: Addition, Subtraction. Multiplication: Signed multiplication, Booth's algorithm.	
	2.3	Division of integers: Restoring and non-restoring division	
3	**Processor Organization and Architecture**		8
	3.1	CPU Architecture, Register Organization, Instruction formats, basic instruction cycle. Instruction interpretation and sequencing.	
	3.2	Control Unit: Soft wired (Micro-programmed) and hardwired control unit design methods. Microinstruction sequencing and execution. Micro operations, concepts of nano programming.	

	3.3	Introduction to RISC and CISC architectures and design issues.	
	3.4	Case study on 8085 microprocessor: Features, architecture, pin configuration and addressing modes.	
4	**Memory Organization:**		8
	4.1	Introduction to Memory and Memory parameters. Classifications of primary and secondary memories. Types of RAM and ROM, Allocation policies, Memory hierarchy and characteristics.	
	4.2	Cache memory: Concept, architecture (L1, L2, L3), mapping techniques. Cache Coherency, Interleaved and Associative memory.	
	4.3	Virtual Memory: Concept, Segmentation and Paging , Page replacement policies	
5	**I/O Organization and Peripherals:**		7
	5.1	Input/output systems, I/O modules and 8089 IO processor	
	5.2	Types of data transfer techniques: Programmed I/O, Interrupt driven I/O and DMA.	
	5.3	Peripheral Devices: Introduction to peripheral devices, scanner, plotter, joysticks, touch pad.	
6	**Introduction to parallel processing systems:**		7
	6.1	Introduction to parallel processing concepts	
	6.2	Flynn's classifications	
	6.3	Pipeline processing, instruction pipelining,	
	6.4	Pipeline stages, pipeline hazards.	
Total			**45**

Text Books:	
1	Carl Hamacher, Zvonko Vranesic and Safwat Zaky, "Computer Organization", Fifth Edition, Tata McGraw-Hill.
2	John P. Hayes, "Computer Architecture and Organization", Third Edition.
3	William Stallings, "Computer Organization and Architecture: Designing for Performance", Eighth Edition, Pearson
4	B. Govindarajulu, "Computer Architecture and Organization: Design Principles and Applications", Second Edition, Tata McGraw-Hill.

References:	
1	Dr. M. Usha, T. S. Srikanth, "Computer System Architecture and Organization",First Edition, Wiley-India
2	"Computer Organization" by ISRD Group, Tata McGraw-Hill
3	Ramesh Gaonkar, "Microprocessor Architecture, Programming and Applications with the 8085, Penram

Useful Links	
1	https://archive.nptel.ac.in/content/storage2/courses/106103068/
2	https://www.javatpoint.com/computer-organization-and-architecture-tutorial

Term Work:
General Instructions:

1	Batch wise tutorials have to be conducted. The number of students per batch will be as per University pattern for practical.
2	Students must be encouraged to write at least 6 class tutorials on the entire syllabus.
3	A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation of 10-15 minutes.

Internal Assessment Test:

The assessment consists of two class tests of 20 marks each. The 1st class test (Internal Assessment I) has to be conducted when approximately 40% of the syllabus is completed. The 2nd class test has to be conducted (Internal Assessment II) when an additional 35% syllabus is Completed. The duration of each test will be for one hour.

End Semester Theory Examination:

1	The question paper will comprise a total of 6 questions, each carrying 20 marks.
2	Out of the 6 questions, 4 questions have to be attempted.
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	In question paper weightage of each module will be proportional to number of respectivelecture hours as mentioned in the syllabus.

Course Code	Course Name	Credit
22303	**Statistics for Data Science**	**4**

Course Objective: The course aims:

1	To understand basic statistical foundations for roles of Data Scientist.
2	To develop problem-solving skills.
3	To infer about the population parameters using sample data and perform hypothesis testing.
4	To understand importance and techniques of predicting a relationship between data and determine the goodness of model fit

Course Outcome: On successful completion, of course, learner/student will be able to:

1	Develop various visualizations of the data in hand.
2	Analyze a real-world problem and solve it with the knowledge gained from sampling and probability distributions.
3	Analyze large data sets and perform data analysis to extract meaningful insights.
4	Develop and test a hypothesis about the population parameters to draw meaningful conclusions.
5	Fit a regression model to data and use it for prediction

Module		Detailed Content	Hours
1		**Introduction to Statistics:**	
	1.1	Categorical and Quantitative Data, Cross-Sectional and Time Series Data.	**8**
	1.2	Descriptive Statistics: Tabular and Graphical Summarizing Categorical Data, Summarizing, Quantitative Data, Cross Tabulations and Scatter Diagram. Statistical Inference,	

	1.3	Descriptive Statistics: Numerical Measures: Measures of Location, Measures of Variability, Measures of Distribution Shape, Relative Location, and Detecting Outliers, Box Plot, Measures of Association Between Two Variables	
2		**Measures of Central Tendency:**	**8**
	2.1	Mean, Median, Mode Measures of Dispersion: Range, Variance, Standard Deviation	
	2.2	Data Visualization: Histograms, Box Plots, Scatter Plots, introduction to Statistical Software Packages: R, Python	
3		**Probability**	**8**
	3.1	Events, Sample Space, Probability Rules	
	3.2	Probability Distributions: Binomial, Poisson, Normal Central Limit Theorem and its Importance in Statistics, Confidence Intervals and Margin of Error	
4		**Inferential Statistics**	**10**
	4.1	Hypothesis Testing: Null and Alternative Hypotheses, Type I and II Errors	
	4.2	Parametric Tests: t-Test, ANOVA,	
	4.3	Non-parametric Tests: Chi-Square Test, Correlation and Regression Analysis	
5		**Multivariate Analysis and Machine Learning**	**7**
	5.1	Multiple Regression and Logistic Regression	
	5.2	Factor Analysis and Principal Component Analysis	
	5.3	Cluster Analysis and Discriminant Analysis	
6		**Advanced Statistical Techniques**	**4**
	6.1	Time Series Analysis: ARIMA Models, Forecasting Bayesian Statistics: Bayes' Theorem	
Total			**45**

Textbooks:

1	Mathematics and Statistics for Economics, 2/e, G.S. Monga, Vikas Publishing
2	Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons
3	An Introduction to Probability Theory and its Applications, W. Feller Wiley
4	Engineering Mathematics Veerarajan T. Tata McGraw-Hill
5	A textbook of Engineering Mathematics, N.P. Bali and Manish, Goyal Laxmi Publications

References:

1	Applied Multivariate Statistical Analysis, Richard A. Johnson, Dean W. Wichern Pearson
2	STATISTICS FOR BUSINESS AND ECONOMICS,11th Edition, David R. Anderson, Dennis J. Sweeney, Thomas A. Williams, South-Western Cengage Learning
3	Probability and Statistics for Engineering and the Sciences, Jay L. Devore, Cengage Publications.
4	Data Science for Dummies Paperback, Wiley Publications, Lillian Pierson
5	Storytelling with Data: A Data Visualization, Guide for Business Professionals, Wiley Publications, Cole Nussbaumer Knaflic

Assessment:
Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3then part (b) will be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to number of respectivelecture hours as mentioned in the syllabus.

Useful Links	
1	https://study.iitm.ac.in/ds/course_pages/BSMA1002.html
2	https://study.iitm.ac.in/ds/course_pages/BSMA1004.html
3	https://onlinecourses.swayam2.ac.in/imb23_mg64/preview

Suggested List of Experiments	
1	Descriptive Statistics: Given a dataset, Compute and interpret the mean, median, mode, variance, and standard deviation
2	Data Visualization: Generate a histogram, box plot, and scatter plot for a given dataset? What insights can you infer from these visualizations
3	Probability Distributions: Identify whether a given dataset follows a normal distribution? If not, can you determine which distribution it follows
4	Hypothesis Testing: Conduct a t-test on a given dataset? What conclusions can you draw at a 5% significance level
5	Correlation: Compute the correlation between two variables in a dataset? How would you interpret the correlation coefficient
6	Simple Linear Regression: Build a simple linear regression model on a given dataset? How would you evaluate the fit of your model
7	Multiple Linear Regression: Construct a multiple linear regression model on a dataset? How do the results compare with the simple linear regression model
8	Logistic Regression: Implement a logistic regression model on a given dataset? How would you assess the classification performance of your model
9	ANOVA: Perform an Analysis of Variance (ANOVA) on a given dataset? What conclusions can you draw from the ANOVA table
10	Chi-Square Test: Conduct a Chi-Square test of independence on a given dataset? Can you determine if there is a significant relationship between the variables

Course Code:	Course Title	Credit
22304	Python Programming	3

Prerequisite: Programming principles with C	
Course Objectives:	
1	Implementing data types, statement, operators and strings
2	Implementing OOPs concept in Python
3	To learn exception & file handling in Python.
4	Connecting with databases
Course Outcomes: On successful completion of course, learner will be able to	
1	Apply the concept of Program structure, Interactive Shell.
2	To understand Data Structures and Program control flow,
3	Apply the concept Functions and Modules & Packages for list manipulation and string manipulation.
4	Understand Classes & Objects for User Defined Data Type, Objects as Instances of Classes.
5	Test Exception Handling & File Operations for Default Exception and Errors.
6	Apply the concept of Database, GUI & Turtle Programming.

Module		Content	Hrs
1		**Introduction to Python**	**8**
	1.1	History & need of Python, Application of Python, Advantages of Python, Disadvantages of Python,	
	1.2	Installing Python, Program structure, Interactive Shell, Executable or script files, 1.3 User Interface or IDE Working with Interactive mode, Working with Script mode, 1.4 Python Character Set, Python Tokens, Keywords, Identifiers, Literals, Operators, Variables and Assignments, Input and Output in Python, DataTypes.	
2		**Data Structures and Program control flow**	**8**
	2.1	Data Structures**:** String Manipulation, List Manipulation, Tuples and Dictionaries, Set and Frozenset.	
	2.2	Program Control Flow:	
	2.3	Conditional Statements: if Statement, if-else Statement, if-elif Statement, Nested if Statements, Python Indentation.	
	2.4	Looping and Iteration: For Loop, While Loop, Loop else Statement, Nested Loops, Break and Continue.	
	2.5	Range Function: Introduction to range(), Types of range() function, Use of range() function.	
3		**Functions and Modules & Packages**	**8**
	3.1	Built-In Functions: Introduction to Functions, Python Function Types, Structure of Python Functions, E.g. - map, zip, reduce, filter, any, chr, ord, sorted, globals, locals, all, etc.	

	3.2	User Defined Functions: Structure of a Python Program w.r.t. UDF, Types of Functions, Invoking UDF, Flow of Execution, Arguments and Parameters, Default Arguments, Named Arguments, Scope of Variables, Lambda function	
	3.3	Recursion Function: Use of recursion function	
	3.4	Modules & Packages: Importing Modules in Python Programs, Working with Random Modules, E.g. - builtins, os, time, datetime, calendar, sys, etc	
4		**Classes & Objects**	**6**
	4.1	Introduction to OOP's: Procedural Vs Modular Programming, Object Oriented Programming, Data Abstraction, Data Hiding, Encapsulation, Modularity, Inheritance, Polymorphism	
	4.2	Classes & Objects: Classes as User Defined Data Type, Objects as Instances of Classes, CreatingClass and Objects, Creating Objects By Passing Values, Variables & Methods in a Class	
5		**Exception Handling & File Operations**	**8**
	5.1	Exception Handling: Default Exception and Errors, Catching Exceptions, Raise anexception, Try -except statement, Raise,Assert, Finally blocks, User defined exception.	
	5.2	File Operations: opening a file, Reading and Writing Files, Other file tools, Regular Expressions.	
6		**Database, GUI**	**7**
	6.1	Database and GUI.	
	6.2	Database: Introduction to MySQL, PYMYSQL Connections, Executing queries, Transactions, Handlingerror.	
	6.3	GUI Programming: Introduction, Tkinter programming, Tkinter widgets, Frame, Button, Label, Entry	
Total			**45**

Textbooks:	
1	Dr. R. Nageswara Rao: Core Python Programming, Dreamtech Press Wiley Publication, 2018 2nd Edition.
2	Zed A. Shaw: Learn Python 3 The Hard Way, Pearson Education, 2017 1st Edition.
References:	
1	Paul Barry: Head First Python: A Brain-Friendly Guide, Shroff/ O. Reilly, 2016 2nd Edition.
2	Charles Dierbach: Introduction to ComputerScience Using Python: AComputational Problem-Solving Focus, Wiley Publication, 2012 1st Edition.
Useful Links for E-resources:	
1	https://www.tutorialspoint.com/python/python_basi c_syntax.html
2	https://machinelearningmastery.com/machine-learning-in-python-step-by-step/
3	https://towardsdatascience.com/beginners-guide-to- machine-learning-with-python-

	b9ff35bc9c51
4	https://nptel.ac.in/courses/106106145

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lectures hours as mention in the syllabus.

List of Practical/ Experiments:

Sr. No	Topic
1	To implement Python program to check whether the given number is even or not.
2	To implement Python program to convert the temperature in degree centigrade to Fahrenheit
3	Python program to find the area of a triangle whose sides are given
4	To Python program to find out the average of a set of integers
5	Python program to find the product of a set of real numbers
6	To implement Python program to find the circumference and area of a circle with a given radius.
7	Python program to check whether the given integer is a multiple of 5
8	To implement Python program to check whether the given integer is a multiple of both 5 and 7.
9	To implement Python program to find the average of 10 numbers using while loop.
10.	To implement Python program to display the given integer in a reverse manner.
11	To implement Python program to find the geometric mean of n numbers.
12	To implement Python program to find the sum of the digits of an integer using a while loop.
13	To implement Python program to display all the multiples of 3 within the range 10 to 50.

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of “Software Engineering”

3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus.

Course Code	Course Name	Credit
22305	Database Management Systems	4

Course Objective: The course aims:	
1	Students will be able to identify and recall the fundamental concepts, principles, and applications of database systems.
2	Students will be able to interpret and describe the principles of relational database design and the roles of various SQL commands.
3	Students will be able to implement and use ER and Relational data models in database design, and construct queries using SQL.
4	Students will be able study and implement transaction management in a database.
Course Outcome: On successful completion, of course, learner/student will be able to:	
1	Describe core concepts of database and model a database management system through ER modeling.
2	Apply knowledge of relational algebra and structured query language to retrieve and manage data from relational database.
3	Demonstrate the use of normalization for database design.
4	Use modern database techniques such as NoSQL.

Module		Detailed Content	Hours
1		**Introduction**	
	1.1	Database System Applications,	**8**
	1.2	Purpose of Database Systems, View of Data, Database Languages	
	1.3	Data Models, Database Users and Administrator	
2		**Database Design and the E-R Model**	**8**
	2.1	Overview of the Design Process, The Entity-Relationship Model, Constraints, Entity Relationship Diagrams	
	2.2	Reduction to Relational Schemas, Schema Diagrams, Entity-Relationship Design Issues, Extended ER features	
3		**Introduction to the Relational Model**	**8**
	3.1	Structure of Relational Databases, Database Schema,	
	3.2	Keys, Relational Algebra, Basic operators of Relational Algebra	
	3.3	Modification of Databases using Relational Algebra, Database Constraints	
4		**Structured Query Language**	**6**
	4.1	Overview of the SQL Query Language, SQL Data Definition,	
	4.2	SQL Constraints, Basic Structure of SQL Queries, Additional Basic Operations	
	4.3	DML operations, Set operations, Aggregate Functions, Nested Sub-queries, Joins, views.	
5		**Relational Database Design**	**8**

	5.1	Features of Good Relational Designs, Problems with bad design, Decomposition using concept of functional dependencies, Armstrong's axioms	
	5.2	Closure of functional dependency, Closure of attribute	
	5.3	Introduction to process of Normalization and denormalization, Normal Forms- 1NF, 2NF, 3NF, BCNF, Denormalization	
6		**Transactions**	7
	6.1	What is Transactions? Properties of transaction, Transaction states,	
	6.2	Issues with concurrent executions, Schedules, Serializability- Conflict and View	
Total			**45**

Textbooks:	
1	Abraham Silberschatz, Henry F. Korth and S. Sudarshan, "Database System Concepts", 7th Edition, McGraw Hill Education, 2019.
2	Gaurav Vaish, Getting Started with NoSQL, 1st edition, Packt Publication, March 2013
3	Brad Daylel, NoSQL with MongoDB in 24 Hours, 1st edition, Sams Teach Yourself, January 2015
References:	
1	R. Elmasri and S. Navathe," Fundamentals of Database Systems", 7th Edition, Pearson Education, 2017.
2	Bob Bryla, Kevin Loney Oracle Database 12C The Complete Reference, 1st edition, Tata McGraw Hill, 2017

Assessment:
Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Useful Links	
1	https://www.geeksforgeeks.org/dbms/
2	https://www.javatpoint.com/dbms-tutorial
3	https://www.tutorialspoint.com/dbms/index.htm

Sr	Suggested List of Experiments
1	Explore various fundamental concepts of DBMS and its future prospective. Introduction to the Oracle, mysql.
2	Apply Data Definition language [DDL] on the relational model designed and apply below constraints on the relational model designed. • Primary key • Unique constraint • Not Null constraint • Foreign key • Check constraint The DDL commands to be implemented are • Create • Alter • Drop
3	Apply Data Manipulation language [DML] on the relational model designed and apply certain constrains on the relational model designed. The commands to be implemented are • Select (without where clause) • Delete • Update
4	To design Entity Relationship and relational model for the given case study.
5	Apply DML select statement with where clause, and, or, not, in, between and like clauses and implement built in functions of SQL.
6	To apply order by clause and concept of different types of Joins for solving queries.
7	To implement group by, having clause, aggregate functions for solving queries.
8	To implement sub queries, set operation and views for solving queries.
9	Demonstrate the use of normalization.
10	To study transaction management commands like commit, Rollback.

Course Code	Course Name	Credits
22306	Web Development	3

Course Objectives: The course aims:	
1	To gain proficiency in HTML5 syntax and semantics, as well as CSS3 for styling and layout, including modern techniques like responsive design and animations.
2	To learn JavaScript basics and DOM manipulation, enabling students to create dynamic and interactive web applications.
3	To understand the role of server-side scripting using PHP and data handling with XML, including database interactions.
4	To familiarize with popular front-end frameworks like React, Angular, and Vue, and understand their benefits and use cases.
5	To understand and utilize XML, including DTD, XML Schema, DOM and SAX parsers, and XSL for data presentation and transformation.
6	To learn how to set up, customize, and manage WordPress blogs, including themes, plugins, and various content management features.
Course Outcomes: On successful completion of course	
1	Students will be able to create well-structured HTML5 documents and apply CSS3 for visual design, including advanced features like animations and media queries.
2	Students will demonstrate the ability to write JavaScript code for basic programming tasks, handle events, and manipulate the DOM to create interactive web pages.
3	Students will develop server-side scripts using PHP and interact with databases.
4	Students will be able to set up and develop applications using front-end frameworks like React, manage state, and implement routing.
5	Students will manage data in XML format, utilizing both DOM and SAX parsers.
6	Students will be able to install and configure WordPress, customize themes, use plugins, and create and manage various types of content on a WordPress site.

Module	Detailed Contents		Hours
1	**Introduction to Web Development**		10
	1.1	Introduction to Internet: World wide web, Internet Addressing ,Browser, URL, Web Server , website , homepage , Domain Name	
	1.2	Software for Web Designing: Notepad/Notepad++,Dreamweaver , Blue Griffon, Net beans, Sea Monkey, Word press, Sublime	
	1.3	HTML5: fundamental syntax, Tables, Lists, Image, HTML5 control elements, Drag and Drop, Audio, Video controls.	
	1.4	CSS3 :Inline, embedded and external style sheets – Rule cascading, Inheritance, Backgrounds, Border Images, Colors, Shadows, Text, Transformations, Transitions, Animation, Basics of Bootstrap.	
2	**JavaScript and DOM Manipulation**		7

	2.1	JavaScript Basics: Variables, data types, and operators, Functions, loops, and conditionals Event handling	
	2.2	Document Object Model (DOM): DOM tree and manipulation , Selecting and modifying elements, Event listeners and event delegation	
3	**PHP**		8
	3.1	Introduction to PHP, PHP Programming Techniques (Data types, Operators, Arrays, Loops, Conditional statements, Functions, Regular expressions).	
	3.2	Form Data Handling with PHP, Database connectivity and handling using PHP-MySQL.	
4	**Front-End Frameworks and Libraries**		10
	4.1	Introduction to Front-End Frameworks: Overview of popular frameworks (React, Angular, Vue), Pros and cons of using frameworks	
	4.2	React Basics: Components, JSX, and props, State and lifecycle methods ,Hooks (useState, useEffect)	
	4.3	Building a Simple React Application: Project setup and tooling , Routing with React Router , State management with Context API or Redux	
5	**XML**		5
	5.1	XML –DTD (Document Type Definition), XML Schema, Presenting XML, Using XML Parsers: DOM and SAX, XSL-eXtensible Stylesheet Language	
6	**WORDPRESS**		5
	6.1	What is WordPress?, Installing WordPress ,Themes , WordPress Plug-ins, Theme Customiser , Menus	
	6.2	Menus, Posts ,Widgets, Posts, Creating pages ,Contact Form 7	
Total			45

Textbooks:	
1	Ralph Moseley, M.T. Savliya, “Developing Web Applications”, Willy India, Second Edition, ISBN: 978-81-265-3867-6
2	“Web Technology Black Book”, Dremtech Press, First Edition, 978-7722-997
3	Robin Nixon, "Learning PHP, MySQL, JavaScript, CSS & HTML5" Third Edition, O'REILLY, 2014.
4	Alex Banks and Eve Porcello, Learning React Functional Web Development with React and Redux,OREILLY, First Edition
References:	
1	Achyut S Godbole and AtulKahate, ―Web Technologies, Second Edition, Tata McGraw Hill, 2012.
2	Thomas A Powell, Fritz Schneider, ―JavaScript: The Complete Reference, Third Edition, Tata McGraw Hill, 2013
3	Steven Holzner ―The Complete Reference - PHP, Tata McGraw Hill, 2008

Useful Links	
1	www.w3schools.com
2	https://books.goalkicker.com/ReactJSBook/
3	https://archive.nptel.ac.in/courses/106/105/106105084/

Internal Assessment Test:

The assessment consists of two class tests of 20 marks each. The 1st class test (Internal Assessment I) has to be conducted when approximately 40% of the syllabus is completed. The 2nd class test has to be conducted (Internal Assessment II) when an additional 40% syllabus is Completed. The duration of each test will be for one hour.

End Semester Theory Examination:

1	The question paper will comprise a total of 6 questions, each carrying 20 marks.
2	Out of the 6 questions, 4 questions have to be attempted.
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	In question paper weightage of each module will be proportional to number of respectivelecture hours as mentioned in the syllabus.

Suggested List of Practical/ Experiments:

Practical Number	Practical/ Experiment
1	Design a home page which displays information about your college department using headings, HTML entitites and paragraphs
2	Create a web page having two frames, Frame 1 containing links and another with contents of the link. When link is clicked appropriate contents should be displayed on Frame 2.
3	Demonstrate difference between "get" and "post" method of form tag in a form with name and password text fields
4	Design an admission form for any course in your college with text, password fields, drop-down list, check-boxes, radio buttons, submit and reset button etc.
5	Create a HTML form with the use of cascading style sheets.
6	Write a JavaScript program to check whether a given positive number is a multiple of 3.
7	Write a JavaScript program to change the case of a string.(i.e upper case to lower case and vice-versa).
8	Develop and demonstrate a HTML file that includes JavaScript script for taking a number n as input using prompt and display first n Fibonacci numbers in a paragraph.
9	Design HTML form for keeping student record, apply JavaScript validation in it for restriction of mandatory fields, numeric field, email-address field, specific value in a field etc.

10	Create a simple React application that displays the current date and time.
11	Create an Angular application that calculates and displays the area of a triangle based on user input.
12	Create a PHP application to insert and display student records from a MySQL database.
13	Setting Up and Customizing a WordPress Site

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of "Software Engineering"
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus.

Program Structure for First Year Big Database and Cloud Computing

UNIVERSITY OF MUMBAI (With Effect from 2023-2024)
Semester IV

Course Code:	Course Title	Credit
22401	**Professional Skill-IV (Aptitude and Logic Building)**	**4**

Prerequisite:	
Course Objectives:	
1	This course aims to provide an exposure in creating and delivering effective multimedia presentations that,
2	To convey the key points for effective communications
3	Able to analyzing data in spreadsheet and writing a technical report.
Course Outcomes:	
1	Understand Programs and Computers
2	Learn how programs and codes operate by using code and scratch.
3	To develop your critical thinking and reasoning skills.
4	The capacity to comprehend searching and sorting
5	Capacity to use formal mathematics to define computer programs (such as recursive functions)
6	Determine the truth value of unquantified phrases by using logical principles to define sets using the list or set builder notation and connecting symbolic laws of logic.

I	**Introduction to Computers**	Computer Systems, Computer Languages, Software Development, Operating System, Number Systems and their conversion, Crypt arithmetic Problems, Pseudocode and Flowchart	**8**
II	**Introduction to Code and Scratch**	Introduction to code (Sequence, if..else and Loops) Design a small code in scratch(animation)	**8**
III	**Critical thinking and logical reasoning**	Critical Thinking: What does it mean to think critically? An overview of definition, Computer programming and logical thinking	**8**
IV	**Searching and Sorting Techniques**	Searching Techniques: Linear Search, Binary Search Sorting Techniques: Selection, Insertion,	**10**

V	**Quantitative Abilities**	Problems on Ages Problems on Profit and Loss Problems on Simple and Compound Interest Problems on Time and Distance	**6**
VI	**Logical Reasoning & Verbal Reasoning**	Number Series Alpha Numerical, Letter & Symbol Series Numerical and Alphabet Puzzles Seating Arrangement Para – Jumble, Text Completion	**5**
Total			**45**

Textbooks:	
1	Computational Thinking, Karl Beecher BCS, The Chartered Institute for IT, 1th Edition,2017
2	Introduction to Algorithm ,Thomas Corman,PHI,3th Edition,2010
References:	
1	Think Smarter: Critical Thinking to Improve Problem-Solving and Decision-Making Skills Michael Kallet, Wiley, 2nd Edition, 2014
Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 10 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and the second class test when an additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Useful Digital Links	
1	https://www.tutorialspoint.com/basics_of_computers/basics_of_ computers_introduction.htm
2	https://plato.stanford.edu/entries/critical-thinking/
3	https://studio.code.org/s/courseb-2020
4	https://scratch.mit.edu/projects/editor/?tutorial=getStarted
5	https://www.careerride.com/mcq/logical-reasoning-quantitative- aptitude-mcq-questions-319.aspx

Suggested List of Experiments	
Sr. No.	**Title of Experiment**
1	A Case study of comparison of different Computer Languages
2	A case study on different Operating Systems
3	Design Pseudocode and Flowchart for a given problem
4	Perform practical on code (Sequence)
5	Perform practical on code (if..else)
6	Perform practical on code (Loops)
7	Perform different events of scratch(animation)
8	Design an animation in scratch.
9	Problems based on Searching Techniques: Linear Search, Binary Search Sorting Techniques: Selection, Insertion,
10	Problems based on Quantitative Abilities and Logical Reasoning & Verbal Reasoning

Course Code	Course Name	Credit
22402	Soft Computing	4

Prerequisite: Probability and Statistics, C++/Java/ Matlab	
Course Objectives:	
1	To familiarize with soft computing concepts.
2	To introduce the fuzzy logic concepts, fuzzy principles and relations.
3	To Basics of ANN and Learning Algorithms.
4	Ann as function approximation.
5	Genetic Algorithm and its applications to soft computing.
6	Hybrid system usage, application and optimization.
Course Outcomes:	
1	List the facts and outline the different process carried out in fuzzy logic, ANN and Genetic Algorithms.
2	Explain the concepts and meta-cognitive of soft computing.
3	Apply Soft computing techniques the solve character recognition, pattern classification, regression and similar problems.
4	Outline facts to identify process/procedures to handle real world problems using soft computing.
5	Evaluate various techniques of soft computing to defend the best working solutions.
6	Design hybrid system to revise the principles of soft computing in various applications.

I	**Fuzzy Set Theory**	Fuzzy Sets: Basic definition and terminology, Basic concepts of fuzzy sets, Fuzzy set operations, Fuzzy relations: Cardinality of fuzzy relations, operations on fuzzy relations, properties of fuzzy relations, Fuzzy composition Fuzzification and Defuzzification: Features of the membership Functions, Fuzzification, Lambda-Cuts for Fuzzy Sets, Lambda-Cuts for Fuzzy Relations, Defuzzification methods	**5**
II	**Fuzzy Rules, Reasoning, and Inference System**	Fuzzy Rules: Fuzzy If-Then Rules, Fuzzy Reasoning Fuzzy Inference System (FIS): Mamdani FIS, Sugeno FIS, Comparison between , Mamdani and Sugeno FIS.	**4**
III	**Neural Network -I**	What is a Neural network? Fundamental Concepts, Basic Models of Artificial Neural Networks, Arificial Intelligence and Neural Networks, McCulloch-Pitts Neuron Learning:Error-Correction Learning, Memory based Learning, Hebbian learning, Competitive Learning, Boltzmann Learning Perceprton:Perceprton Learning Rule, Perceptron Learning Algorithm, Perceprton Convergence Theorem, Perceptron learning and Non-separable sets. Rule-Based Approach: Classification, Tests, Rules Artificial Neural Network:	**6**

IV	**Neural Networks -II**	**Back propaggation:** Multilayered Network Architecture, Back porpagation Algorithm, Practical Consideration in impin Implementing the Back propagation Algorithm. Back propagation and XOR problem. **Adaptive resonance Theory:** Noise-Saturation Dilemma, Solving the Noise-Saturation Dilemma, Recurrent On-center-Off-surround Networks, Adaptive Resonance Theory I (ART I), Neurophysiological Evidence for ART Mechanism **Character Recognition:** Introduction, General Algorithm Architecture for Character Recognition:	**10**
V	**Genetic Algorithm**	An Introduction to genetic Algorithms: What Are Genetic Algorithms? Robustness of Traditional Optimization and Search Methods, The Goals of Optimization, How Are Genetic Algorithms Different from Traditional Methods?, A Simple Genetic Algorithm Genetic Algorithms at Work. Genetic Algorithms: Mathematical Foundations Who Shall Live and Who Shall Die? The Fundamental Theorem, Schema Processing at Work: An Example by Hand Revisited, The Two-armed and й-armed Bandit Problem, Implementation of a Genetic Algorithm: Data Structures, Reproduction, Crossover, and Mutation, Algorithm for Handwriting Recognition Using GA Generation of Graph, Fitness Function of GA: Deviation between Two Edges, Deviation of a Graph, Crossover: Matching of Points, Generate Adjacency Matrix, Find Paths, Removing and Adding Edges, Generation of Graph.	**10**
VI	**Hybrid Computing**	Introduction, Neuro-Fuzzy Hybrid Systems, Adaptive Neuro-Fuzzy Inference System (ANIFS): Introduction, ANFS Architecture, Hybrid Learning Algorithm, ANFIS as a Universal Approximator, Simulation Examples: Two-input Sinc Function and Three Input Nonlinear Function Genetic Neuro-Hybrid Systems: Properties of Genetic Neuro-Hybrid Systems, genetic Algorithm based Back-propagation Network, Advantages of Neuro-Genetic Hybrids, Genetic Fuzzy Hybrid and Fuzzy Genetic Hybrid Systems Genetic Fuzzy Rule based Systems, Advantages of Genetic Fuzzy Hybrids	**10**
		Total	**45**

Textbooks:	
1	1. . S.N. Sivanandan and S.N. Deepa, Principles of Soft Computing, Wiley India, 2007, ISBN: 10: 81-265-1075-7.
2	J.-S. R. Jang, C. –T. Sun, E. Mizutani, Neuro-Fuzzy and Soft Computing, A Computational Approach to Learning and Machine Intelligence, PHI Learning Private Limited-2014
3	Neural Networks: A Classroom Approach, Satish Kumar, Tata McGraw-Hill Education, 2004/2007
4	Simon Haykin, Neural Networks A Comprehensive Foundation, Second Edition, Pearson Education-2004

5	David E. Goldberg, Genetic Algorithms, in search, optimization and Machine Learning, Pearson
References:	
1	Anupam Shukla, Ritu Tiwari, Rahul Kala, Real Life Applications of Soft Computing, CRC Press,Taylor & Francis Group, 2010.
2	Genetic Algorithms and Genetic Programming Modern Concepts and Practical Applications © 2009 Michael Affenzeller, Stephan Winkler, Stefan Wagner, and Andreas Beham, CRC Press
3	Laurene V. Fausett, Fundamentals of Neural Networks: Architectures, Algorithms And Applications, Pearson
Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and the second class test when an additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Useful Digital Links	
1	http://www.digimat.in/nptel/courses/video/106105173/L01.html
2	http://www.digimat.in/nptel/courses/video/127105006/L37.html
3	https://www.digimat.in/nptel/courses/video/106105173/L38.html
4	https://www.youtube.com/watch?v=Z_8MpZeMdD4
5	https://www.youtube.com/watch?v=Fs5ZIjp1hUk

Suggested List of Experiments	
Sr. No.	**Title of Experiment**
1	Implement different fuzzy operations
2	Implement different fuzzy membership functions
3	Implement different fuzzy relations
4	Implement fuzzy controller
5	Implement any supervised learning algorithm
6	Implement an unsupervised Learning algorithm

7	Implement any application using genetic algorithm
8	Case Study on Fuzzy Logic challenges
9	Case Study on Neural Network
10	Mini Project on Fuzzy Logic and Neural Network for Engineering Application

Course Code	Course Name	Credit
22403	**Information Storage Concept**	4

Prerequisite: Database Management Systems, Computer Networks.	
Course Objectives:	
1	To understands key elements of a data center environment
2	To introduce to Disk Performance
3	To introduce to RAID and intelligence of storage system
4	To understand storage connectivity technologies
Course Outcomes:	
1	Explain the key elements of a data center environment.
2	Determine storage design based on application requirements and disk performance.
3	Apply RAID and intelligent storage systems for flexible information-centric strategy.
4	Apply storage connectivity technologies.
5	Analyze network-attached storage and object-based storage. (L4)

I	**Introduction to Information Storage Technology:**	Review data creation and the amount of data being created and understand the value of data to a business, Challenges in Data Storage and Management, Data Storage Infrastructure. Storage Systems Environment: Components of a Storage System Environment: Disk drive components, Disk Drive Performance, Logical Components	**8**
II	**Data protection**	Concept of RAID and its Components, Different RAID levels and their suitability for different application environments: RAID 0, RAID 1, RAID 3, RAID 4, RAID 5, RAID 0+1, RAID 1+0, RAID 6, Comparison of Levels. Intelligent Storage Systems: Components, Intelligent Storage Array, High-level architecture and working of an intelligent storage system.	**8**
III	**Introduction to Networked Storage**	Evolution of networked storage, Architecture, Overview of FC-SAN, NAS, and IP-SAN. Network-Attached Storage (NAS): Benefits of NAS, Components, Implementations, File Sharing, I/O operations, Performance and Availability. .	**5**
IV	**Content Addressed Storage (CAS)**	features and Benefits of a CAS. CAS Architecture, Storage and Retrieval, Examples. Storage Virtualization: Forms, Taxonomy, Configuration, Challenges, Types of Storage Virtualizations.	**10**
V	**Information Availability & Monitoring & Managing Datacenter**	Information Availability, Business continuity, Failure Analysis, Business impact Analysis, Differentiate between business continuity (BC) and disaster recovery (DR). Disaster Recovery: Backup, Methods, And Technologies, Replication technologies: Local replicas, Technologies, Restore and Restart, Multiple Replicas. Remote Replication. DR in practice	**6**

VI	**Storage Security and Managemen t**	Security Framework, Storage security domains, List and analyzes the common threats in each domain, Security Implementations. Managing The Storage Infrastructure: Monitoring the Storage Infrastructure, Storage Management Activities, Challenges and solutions.	**8**
Total			**45**

Textbooks:	
1	G.Somasundaram, A.Shrivastava, ―Information Storage and Management: Storing, Managing and Protecting Digital Information in Classic, Virtualized and Cloud Environment, 2 nd Edition, Wiley publication, 2012, Reprint 2016
References:	
1	Nigel Poulton, ―Data Storage Networking‖, 1st Edition, Wiley publication, 2014.
2	Tom Clark, ―Storage Virtualization: Technologies for Simplifying Data Storage and Management, 1st Edition, Pearson Education, 2018.
Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and the second class test when an additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Useful Digital Links	
1	http://www.ictacademy.in/Pages/Information-Storage-and-Management.aspx
2	https://nptel.ac.in/courses/106/108/106108058

Suggested List of Experiments	
Sr. No.	**Title of Experiment**
1	Case study on development storage drives
2	Case study on HDD, SDD
3	Practical on File sharing and security.
4	Case study on data centers infrastructure
5	Study of RAID technology and their implementation

Course Code	Course Name	Credit
22404	Data Mining and Data ware Housing	4

Course Objective: The course aims:	
1	Students will be able to describe and explain the principles, architectures, applications, design, and implementation of data warehousing and data mining.
2	Students will be able to utilize the mathematical foundations of data mining tools in various scenarios.
3	Students will be able to examine and interpret classical models and algorithms in data warehouses and data mining.
4	Students will be able to assess and judge the kinds of patterns that can be discovered by association rule mining, classification, and clustering.
Course Outcome: On successful completion, of course, learner/student will be able to:	
1	Students will be able to articulate the principles, architectures, applications, design, and implementation of data warehousing and data mining.
2	Students will be able to apply the mathematical foundations of data mining tools to solve complex problems.
3	Students will be able to implement and optimize classical models and algorithms in data warehouses and data mining.
4	Students will be able to identify and interpret patterns discovered by association rule mining, classification, and clustering.

Module		Detailed Content	Hours
1		**Data Mining Introduction**	
	1.1	Data Mining definitions, KDD vs Data Mining, DBMS vs DM, DM Techniques, Issues and Challenges in DM, DM Applications	8
	1.2	Association Rules: What is an Association Rule?, Methods to Discover Association Rules, A Priori Algorithm, Partition Algorithm, FP-Tree Growth Algorithm, Discussion on Different Algorithms, Generalized Association Rule, Association Rules with Item Constraint	
II		**Clustering Techniques**	**8**
	2.1	Clustering Paradigms, Partitioning Algorithms, k-Medoid Algorithms, CLARA, CLARANS	
	2.2	Hierarchical Clustering, DBSCAN, CURE, Categorical Clustering Algorithms, STIRR, ROCK,	
III		**Decision Trees:**	**8**
	3.1	What is a Decision Tree?, Tree Construction Principle, Best Split, Splitting Indices, Splitting Criteria	
	3.2	Decision Tree Construction Algorithms, CART, ID3, C4.5, Decision Tree Construction with Presorting	
IV		**Data Warehouse Fundamentals**	**10**
	4.1	Introduction to Data Warehousing, OLTP Systems vs Data Warehouses, Data Warehouse Development, Planning and Requirements	
	4.2		

V		**Data Warehouse Architecture**	**6**
	5.1	Introduction to Data Warehouse Components,	
	5.2	Dimensional Modelling, Data Warehouse Schemas, Extract, Transform and Load (ETL)	
VI		**Data Warehouse & OLAP**	5
	6.1	Introduction to OLAP, Multidimensional Data	
	6.2	OLAP Architectures, Metadata Management in Data Warehouse	
Total			45

Textbooks:	
1	Alex Berson and Stephen J. Smith "Data Warehousing, Data Mining & OLAP", Tata cGraw – Hill Edition, Tenth Reprint 2007.
2	K.P. Soman, Shyam Diwakar and V. Ajay "Insight into Data mining Theory and Practice", Easter Economy Edition, Prentice Hall of India, 2006.
3	Data Mining Techniques, Arun K Pujari, University Press
4	Data Mining: Concepts and Techniques, 3rd Edition, Jiawei Han, Micheline Kamber, Jian Pe
5	Database Systems: Introduction to Databases and Data Warehouses 1st Edition by NenadJukic ,Susan Vrbsky , SvetlozarNestorov
References:	
1	G. K. Gupta "Introduction to Data Mining with Case Studies", Easter Economy Edition, Prentice Hall of India, 2006.
2	Pang-Ning Tan, Michael Steinbach and Vipin Kumar "Introduction to Data Mining", Pearson Education, 2007.
3	The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling, 3rd Edition by Ralph Kimball

Assessment:
Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of 6 questions, each carrying 20 marks.
2	The students need to solve total 4 questions.
3	Question No.1 will be compulsory and based on entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

Useful Links	
1	https://www.tutorialspoint.com/data_mining/index.htm
2	https://www.tutorialspoint.com/market/index.asp
3	https://www.geeksforgeeks.org/data-warehousing/

Suggested List of Experiments	
1	Star Schema Design: Construct a star schema for a retail business, incorporating dimensions such as time, product, location, and customer.
2	K-Means Clustering: Utilize a dataset of your choice and implement the k-means clustering algorithm. Analyze and interpret the resulting clusters.
3	ETL Process Design: Given a raw dataset, devise an ETL process to clean, transform, and load the data into a data warehouse.
4	OLAP Operations: Execute various OLAP operations like roll-up, drill-down, slice, and dice on a multi-dimensional dataset.
5	Apriori Algorithm: Implement the Apriori algorithm on a transaction dataset to discover frequent itemsets and generate association rules.
6	Snowflake Schema Design: Develop a snowflake schema for a healthcare system, including dimensions such as time, patient, doctor, and hospital.
7	Naive Bayes Classifier: Apply the Naive Bayes classifier on a dataset of your choice to predict a specific outcome. Evaluate the model's performance.
8	Data Reduction Techniques: Implement data reduction techniques such as aggregation, histogram analysis, and dimensionality reduction on a given dataset.
9	Decision Tree Algorithm: Use the decision tree algorithm on a dataset to classify instances. Interpret the resulting decision tree.
10	OLAP Operations on Data Cube: Perform various OLAP operations on a data cube and interpret the results

Course Code	Course Name	Credit
22405	**Introduction to Big Data**	4

Course Objective: The course aims:	
1	Students will be able to explain the concept of Big Data and the 4 V's of Big Data Applications.
2	Students will be able to identify and describe the trends of computing for Big Data including high-performance computing, grid computing, cloud computing, and mobile computing.
3	Students will be able to understand and use various Big Data tools, techniques, and systems such as HDFS, HBase, NoSQL, MapReduce, Spark, Hive, etc.
4	Students will be able to apply advanced analytical theory and methods such as recommendation, clustering, classification, and regression using Hadoop/Mahout.
Course Outcome: On successful completion, of course, learner/student will be able to:	
1	Students will be able to articulate the principles and applications of Big Data, demonstrating a clear understanding of its attributes and structures.
2	Students will be able to utilize high-performance computing, grid computing, cloud computing, and mobile computing for Big Data processing.
3	Students will be able to effectively use various Big Data tools and systems to analyze and interpret data.
4	Students will be able to apply advanced analytical theory and methods to solve complex problems using Big Data

Module		Detailed Content	Hours
1		**Introduction**	8
	1.1	Introduction to Big data, benefits, infrastructure requirement	
	1.2	4 V's of Big Data Applications	
II		**Trends of Computing for Big Data**	8
	2.1	Trends of computing for big data and developments	
	2.2	High-performance Computing (Supercomputers and Clusters), Grid Computing Cloud Computing, Mobile Computing	
III		**Big Data for analytics**	8
	3.1	Drivers of Big Data, Big Data Attributes,	
	3.2	Data Structures, Big Data Ecosystem, Examples of Data Analytics	
IV		**Big Data Tools, Techniques, and Systems**	10
	4.1	Exascale Computing, HDFS, HBase, and NoSQL (Document Store, Graph DB, etc.)	
	4.2	MapReduce, Spark, Oozie, Tez, Hive, Pig, etc., Hadoop 1 and Hadoop 2 (YARN)	
V		**Advanced Analytical Theory and Methods**	6
	5.1	Hadoop/Mahout	
	5.2	Recommendation, Clustering	

	5.3	Classification, Regression	
VI		**Advanced Topics**	5
	6.1	Big Data Visualization, High-performance Networking for Big Data Movement	
	6.2	Big Data Scientific Workflow Management and Optimization	
Total			**45**

Textbooks:	
1	Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph. By David Loshin, Elsevier, August 23, 2013
2	Anand Rajaraman and Jeff Ullman "Mining of Massive Datasets", Cambridge University Press,
3	Alex Holmes "Hadoop in Practice", Manning Press, Dreamtech Press.
4	Dan McCreary and Ann Kelly "Making Sense of NoSQL" – A guide for managers and the rest of us, Manning Press.
5	Bill Franks , "Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams With Advanced Analytics", Wiley
References:	
1	Judith Hurwitz, Alan Nugent, Dr. Fern Halper, Marcia Kaufman, "Big Data for Dummies", Wiley India
2	Michael Minelli, Michele Chambers, Ambiga Dhiraj, "Big Data Big Analytics: Emerging Business Intelligence And Analytic Trends For Today's Businesses", Wiley India
3	Phil Simon, "Too Big To Ignore: The Business Case For Big Data", Wiley India
4	Paul Zikopoulos, Chris Eaton, "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data', McGraw Hill Education.
5	Boris Lublinsky, Kevin T. Smith, Alexey Yakubovich, "Professional Hadoop Solutions", Wiley India.

Assessment:
Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of 6 questions, each carrying 20 marks.
2	The students need to solve total 4 questions.
3	Question No.1 will be compulsory and based on entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

Useful Links	
1	https://www.analyticsvidhya.com/blog/2014/05/hadoop-simplified/
2	https://www.analyticsvidhya.com/blog/2014/05/introduction-mapreduce/
3	https://www.tutorialspoint.com/big_data_analytics/index.htm

Suggested List of Experiments	
1	Study of Hadoop ecosystem
2	Two programming exercises on Hadoop
3	Two programming exercises in No SQL
4	Implementing simple algorithms in Map- Reduce (3) - Matrix multiplication,
5	Aggregates, joins, sorting, searching etc.

6	Implementing any one Frequent Itemset algorithm using Map-Reduce
7	Implementing any one Clustering algorithm using Map-Reduce
8	Implementing any one data streaming algorithm using Map-Reduce
9	Mini Project: One real life large data application to be implemented (Use standard Datasets available on the web) a) Twitter data analysis b) Fraud Detection c) Text Mining etc.

Course Code	Course Name	Credit
22406	**Network Security & Cryptography**	**4**

Prerequisite: Computer Network	
Course Objectives:	
1	To understand Security Trends And Cryptography Concepts.
2	To know the Symmetric Key Cryptography and Asymmetric Key Cryptography
3	To understand Authentication And system security.
Course Outcomes:	
1	Understand Security Trends And Concepts.
2	Explore Classical And Modern Cryptography.
3	Master the Mathematics Of Symmetric Key Cryptography.
4	Understand Asymmetric Key Cryptography.
5	Understand Authentication And Network Access Control.

I	Introduction	Security trends – Legal, Ethical and Professional Aspects of Security, Need for Security at Multiple levels, Security Policies – Model of network security – Security attacks, services and mechanisms – OSI security architecture – Classical encryption techniques: substitution techniques, transposition techniques, steganography- Foundations of modern cryptography: perfect security – information theory – product cryptosystem – cryptanalysis.	**10**
II	**Symmetric Key Cryptography**	MATHEMATICS OF SYMMETRIC KEY CRYPTOGRAPHY: Algebraic structures – Modular arithmetic-Euclid?s algorithm-Congruence and matrices -Groups, Rings, Fields- Finite fields-SYMMETRIC KEY CIPHERS: SDES – Block cipher Principles of DES – Strength of DES – Differential and linear cryptanalysis – Block cipher design principles – Block cipher mode of operation – Evaluation criteria for AES – Advanced Encryption Standard – RC4 –Key distribution.	**08**
III	**Public Key Cryptography**	MATHEMATICS OF ASYMMETRIC KEY CRYPTOGRAPHY: Primes – Primality Testing –Factorization – Euler‘s totient function, Fermat‘s and Euler‘s Theorem – Chinese Remainder Theorem – Exponentiation and logarithm – ASYMMETRIC KEY CIPHERS: RSA cryptosystem – Key distribution – Key management – Diffie Hellman key exchange -ElGamal cryptosystem – Elliptic curve arithmetic-Elliptic curve cryptography.	**12**
IV	**Message Authentication And Integrity**	Authentication requirement – Authentication function – MAC – Hash function – Security of hash function and MAC – SHA –Digital signature and authentication protocols – DSS- Entity Authentication: Biometrics, Passwords, Challenge Response protocols- Authentication applications – Kerberos, X.509	**8**

V	**Network Security**	Network Access Control: Network Access Control, Extensible Authentication Protocol, IEEE 802.1X Port-Based Network Access Control Electronic Mail security – PGP, S/MIME – IP security – Web Security – SYSTEM SECURITY: Intruders – Malicious software – viruses – Firewalls.	**10**
VI	**Advance Topics**	Blockchains, Cloud Security and IoT security.	**2**
Total			**45**

Textbooks:	
1	Cryptography and Network Security Principles And Practice William Stallings, Pearson Education, Eigth Edition.
References:	
1	Cryptography and Network Security ,Behrouz A Forouzan, Debdeep Mukhopadh yay ,McGrawHill ,3rd Edition, 2015
2	Bruce Schneier, “Applied Cryptography”, John Wiley & Sons Inc, 2001
3	Maiwald, “Fundamentals of Network Security”, Wiley Student Edition, 2006
4	Charles B. Pfleeger and Shari Lawrence Pfleeger, “Security in Computing”, 3rd Edition, PearsonEducation, 2003
5	
Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and the second class test when an additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Useful Digital Links	
1	https://www.youtube.com/watch?v=rA_ZmWPormM
2	https://youtu.be/C7vmouDOJYM

Suggested List of Experiments	
Sr. No.	**Title of Experiment**
1	Simulate Buffer overflow attack using Splint
2	To implement a program in java for password cracking using Brute Force.
3	Implementation of Caesar cipher
4	Implementation of Playfair cipher
5	Implement RSA algorithm.
6	Implement Diffie Hellman Algorithm
7	Study the use of network reconnaissance tools like WHOIS, dig, traceroute, ns lookup to gather information about networks and domain registrars.
8	Study of packet sniffer tools : wireshark, :
	1. Download and install wireshark and capture icmp, tcp, and http packets in promiscuous mode.
	2. Explore how the packets can be traced based on different filters..

Semester V

Course Code:	Course Title	Credit
22501	Professional Skill-V (R-Programming)	4

Prerequisite: General Programming Concepts and Introductory Statistics	
Course Objectives:	
1	Understand and apply the fundamentals of R programming for data manipulation and analysis.
2	Perform statistical computations and interpret results using R to solve real-world problems.
3	Create effective data visualizations using R packages to communicate insights clearly.
4	Develop and execute basic scripts in R to automate data processing tasks.
5	Utilize R for exploratory data analysis and reporting in a professional context.
Course Outcomes:	
1	To write R code to import, clean, and transform datasets efficiently.
2	To demonstrate the ability to conduct statistical tests and summarize findings using R.
3	Producing professional-quality charts, graphs, and plots using R's visualization tools.
4	To automate repetitive data tasks by writing reusable R scripts.
5	To apply R programming skills to analyze real-world datasets and present actionable insights.

Module		Content	Hrs
1		**Introduction to R and RStudio**	**8**
	1.1	Overview of R and its applications in data analysis.	
	1.2	R environment: console, scripts, and workspace.	
	1.3	Basic syntax, variables, and data types (vectors, matrices, lists).	
	1.4	Working with R packages (installation and loading).	
2		**Data Structures and Data Import**	**7**
	2.1	Understanding R data structures: data frames, factors, and arrays.	
	2.2	Importing data: CSV, Excel, and text files.	
	2.3	Data exploration: summary statistics, head(), tail(), str().	
	2.4	Handling missing data and basic data cleaning.	
3		**Data Manipulation with R**	**7**
	3.1	Data Wrangling Basics: Using dplyr to filter, select, and summarize data.	
	3.2	Transforming Data: Creating new variables and handling simple joins.	
	3.3	Practical examples of data preprocessing.	
4		**Statistical Analysis with R**	**8**
	4.1	Descriptive statistics: mean, median, variance, etc.	
	4.2	Probability distributions in R (normal, binomial, etc.).	

	4.3	Hypothesis testing: t-tests, chi-square tests.	
	4.4	Correlation and basic regression analysis.	
	4.5	Interpreting statistical output in R.	
5		**Data Visualization with R**	**7**
	5.1	Intro to ggplot2: Creating bar charts and scatter plots with basic customization.	
	5.2	Visualizing Insights: Exporting plots for reports or presentations.	
	5.3	Creating bar charts, line graphs, scatter plots, and boxplots. Customizing plots: themes, labels, and colors.	
	5.4	Visualizing relationships and trends in data.	
	5.5	Exporting visualizations for reports.	
6		**Applied R Programming and Projects**	**8**
	6.1	Scripting Basics: Writing a simple function or loop to automate a task.	
	6.2	Case studies: real-world data analysis (e.g., sales data, survey data).	
	6.3	Building a mini-project: data cleaning, analysis, and visualization.	
	6.4	Presenting results in a professional format.	
Total			**45**

Textbooks:	
1	Sandip Rakshit, "R Programming for Beginners", McGraw Hill India, Edition 1, 2017, ISBN: 9789352604555
2	Hadley Wickham, Garrett Grolemund, "R for data science : Import, Tidy, Transform, Visualize, And Model Data", O'Reilly, ISBN: 9781491910399

Reference books:	
1	Norman Matloff, "The art of R programming: A tour of statistical software design", No Starch Press, ISBN: 9781593273842
2	Andy Field, "Discovering Statistics Using R", Sage publications, ISBN: 9781446200469
3	Andrie De Vries and Joris Meys, "R for Dummies", John Wiley & Sons, ISBN: 9781119962847

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 10 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Useful Links	
1	https://archive.nptel.ac.in/courses/111/104/111104100/
2	https://www.datacamp.com/tracks/r-programming
3	https://education.rstudio.com
4	https://www.statmethods.net

List of Tutorial:

Tutorial Number	Tutorial Topic
1	Getting Started with RStudio.
2	Cleaning a Messy Dataset.
3	Performing a t-test in R.
4	Exploratory Data Analysis (EDA).
5	Writing Your First R Script.

Course Code	Course Name	Credits
22502	Management Information System	4

Prerequisite: Introduction to Information Technology or Basic Computer Applications	
Course Objectives:	
1	To introduce students to the fundamental concepts and types of Management Information Systems and their role in organizational decision-making.
2	To develop an understanding of how MIS integrates technology with business processes to enhance efficiency and competitiveness.
3	To equip students with skills to analyze, design, and implement information systems for business applications.
4	To explore the strategic importance of MIS in achieving organizational goals and managing data effectively.
5	o familiarize students with emerging technologies (e.g., AI, Big Data) and their applications in modern MIS.
Course Outcomes:	
1	To explain the components, types, and functions of MIS in a business context.
2	To demonstrate the ability to use MIS tools to support managerial decision-making and problem-solving.
3	To design basic information systems or databases to address specific organizational needs.
4	To evaluate the impact of MIS on organizational strategy, operations, and competitive advantage.
5	Apply knowledge of emerging technologies to propose innovative solutions for business challenges.

Module	Detailed Contents		Hours
1	**Introduction to Management Information Systems**		8
	1.1	Overview of MIS: Definition, Importance, and Evolution.	
	1.2	Types of MIS: Transaction Processing Systems, Decision Support Systems, Executive Information Systems.	
	1.3	Role of MIS in Organizations: Operational, Tactical, and Strategic Levels.	
	1.4	MIS Frameworks: CCR (Capabilities, Complements, Role).	
2	**Information Technology Infrastructure**		8
	2.1	Hardware, Software, and Network Components of MIS.	
	2.2	IT Infrastructure: Cloud Computing, Servers, and Storage.	
	2.3	Data Communication and Networking Basics.	
	2.4	Emerging Technologies: IoT, AI, and Blockchain in MIS	
3	**Database Management and Business Intelligence**		9
	3.1	Database Concepts: Relational Databases, Data Models.	

	3.2	Data Warehousing and Data Mining Techniques.	
	3.3	Foundations of Business Intelligence: Reporting and Analytics.	
	3.4	Data Visualization and Decision-Making Tools.	
4	**MIS in Business Processes**		9
	4.1	MIS Applications: Enterprise Resource Planning (ERP), Customer Relationship Management (CRM)	
	4.2	E-Commerce and Digital Markets: Technology and Strategies.	
	4.3	Transaction Processing Systems and Operational Excellence.	
	4.4	MIS for Collaboration and Knowledge Management.	
5	**Strategic Management and Implementation of MIS**		11
	5.1	Strategic Role of MIS in Organizations.	
	5.2	MIS Planning, Development, and Implementation Lifecycle.	
	5.3	Security and Ethical Issues in MIS.	
	5.4	Case Studies: Successful MIS Implementations and Challenges.	
Total			**45**

Text Books:	
1	Waman S. Jawadekar, “Management Information Systems”, Tata McGraw-Hill.
2	Shubhra Garg, “Management Information Systems”, Himalaya Publishing House.

References:	
1	James A. O’Brien and George M. Marakas, “Management Information Systems”, McGraw-Hill
2	Barbara C. McNurlin and Ralph H. Sprague, "Information Systems Management in Practice", Pearson.
3	Ralph Stair and George Reynolds, "Fundamentals of Information Systems", Cengage Learning.

Term Work:	
General Instructions:	
1	Batch wise tutorials have to be conducted. The number of students per batch will be as per University pattern for practical.
2	Students must be encouraged to write at least 6 class tutorials on the entire syllabus.
3	A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation of 10-15 minutes.

Internal Assessment Test:

The assessment consists of two class tests of 20 marks each. The 1st class test (Internal Assessment I) has to be conducted when approximately 40% of the syllabus is completed. The 2nd class test has to be conducted (Internal Assessment II) when an additional 35% syllabus is Completed. The duration of each test will be for one hour.

End Semester Theory Examination:

1	The question paper will comprise a total of 6 questions, each carrying 20 marks.
2	Out of the 6 questions, 4 questions have to be attempted.

3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	In question paper weightage of each module will be proportional to number of respectivelecture hours as mentioned in the syllabus.

Useful Links	
1	https://archive.nptel.ac.in/courses/110/105/110105148/
2	https://swayam.gov.in

List of Tutorial:

Tutorial Number	**Tutorial Topic**
1	Analyzing Business Data with Excel.
2	Introduction to Data Visualization Tools (e.g., Tableau).
3	Building a Simple Database Using MS Access or MySQL.
4	Exploring Cloud-Based MIS Tools (e.g., Google Workspace).

Course Code	Course Name	Credit
22503	**Information Retrieval system**	4

Prerequisite: Data Structures and Algorithms or Database Management Systems	
Course Objectives:	
1	To introduce students to the principles and techniques of information retrieval in digital systems.
2	To develop skills in designing and evaluating retrieval models for text and multimedia data.
3	To explore indexing, searching, and ranking mechanisms used in modern information retrieval systems.
4	To familiarize students with applications of IRS, including web search engines and recommender systems.
5	To provide hands-on experience with tools and algorithms for efficient information retrieval.
Course Outcome:	
1	Explain the architecture and components of an information retrieval system.
2	Design and implement basic retrieval models for structured and unstructured data.
3	Evaluate the performance of IRS using metrics like precision, recall, and F-measure.
4	Apply indexing and querying techniques to optimize retrieval efficiency.
5	Analyze real-world IRS applications, such as search engines and content recommendation.

Module		Detailed Contents	Hours
1		**Introduction to Information Retrieval**	
	1.1	Overview of IRS: Definition, Scope, and Importance.	**7**
	1.2	Types of Information Retrieval: Text, Image, Audio, Video.	
	1.3	IRS vs. Database Systems: Key Differences.	
	1.4	Basic Retrieval Process: Querying, Matching, and Ranking.	
2		**Information Retrieval Models**	**8**
	2.1	Boolean Retrieval Model: Concepts and Limitations.	
	2.2	Vector Space Model: Term Weighting (TF-IDF), Cosine Similarity.	
	2.3	Probabilistic Models: BM25 and Relevance Feedback.	
	2.4	Evaluation Metrics: Precision, Recall, MAP (Mean Average Precision)	
3		**Indexing and Data Structures**	**8**
	3.1	Inverted Index: Construction and Optimization.	
	3.2	Text Preprocessing: Tokenization, Stemming, Stop Words.	
	3.3	Data Structures for IRS: Tries, Suffix Trees, Hashing.	
	3.4	Compression Techniques for Indexes.	
4		**Query Processing and Search Algorithms**	**7**
	4.1	Query Parsing and Reformulation.	

	4.2	Search Algorithms: Exact Match, Approximate Match.	
	4.3	Ranking Algorithms: PageRank, HITS.	
	4.4	Spell Correction and Autocompletion in Queries	
5		**Advanced Topics in IRS**	**7**
	5.1	Web Information Retrieval: Crawling, Indexing, and Link Analysis.	
	5.2	Multimedia Retrieval: Image and Video Search Techniques.	
	5.3	Recommender Systems: Collaborative Filtering, Content-Based Filtering.	
	5.4	Natural Language Processing in IRS: Word Embeddings, BERT	
6		**Practical Implementation and Evaluation**	**8**
	6.1	Tools and Frameworks: Apache Lucene, Elasticsearch.	
	6.2	Building a Simple Search Engine: Hands-On Project.	
	6.3	Performance Evaluation: Benchmarking and User Studies.	
	6.4	Challenges in IRS: Scalability, Latency, and Relevance.	
Total			**45**

Textbooks:	
1	"Information Retrieval" by G.G. Chowdhury and Sudatta Chowdhury, PHI Learning (India).
2	"Introduction to Information Retrieval and Text Mining" by R. Rajendra Prasad, S. Chand Publishing.
3	"Introduction to Information Retrieval" by Christopher D. Manning, Prabhakar Raghavan, and Hinrich Schütze, Cambridge University Press.
4	"Search Engines: Information Retrieval in Practice" by Bruce Croft, Donald Metzler, and Trevor Strohman, Pearson.
References:	
1	"Modern Information Retrieval" by Ricardo Baeza-Yates and Berthier Ribeiro-Neto, Addison-Wesley.
2	"Information Retrieval: Algorithms and Heuristics" by David A. Grossman and Ophir Frieder,Springer.
3	"Text Data Management and Analysis" by ChengXiang Zhai and Sean Massung, Morgan & Claypool.
4	Data Science for Dummies Paperback, Wiley Publications, Lillian Pierson

Assessment:
Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3then part (b) will be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to number of respectivelecture hours as mentioned in the syllabus.

Useful Links

1	https://nlp.stanford.edu/IR-book/
2	https://www.elastic.co/guide/en/elasticsearch/

List of Practical/ Experiments:

Sr. No	Topic
1	Use NLTK to preprocess a text dataset (e.g., news articles) with tokenization and stemming.
2	Build an inverted index in Python for a small document collection (e.g., 20 text files).
3	Implement a Boolean retrieval system for a dataset (e.g., Wikipedia snippets) with AND/OR/NOT queries.
4	Compute TF-IDF scores and retrieve top documents for a query (e.g., movie descriptions).
5	Use the vector space model to rank documents based on cosine similarity (e.g., blog posts)
6	Create a basic web crawler with BeautifulSoup to collect data (e.g., news headlines).
7	Index a text corpus (e.g., research abstracts) and perform searches using Lucene.
8	Enhance a retrieval system with synonym expansion using WordNet and compare results.
9	Calculate precision, recall, and MAP for a retrieval system on a labeled dataset (e.g., TREC).
10.	Build an end-to-end search engine for a small corpus (e.g., articles) with indexing and ranking.

Course Code:	Course Title	Credit
22504	Machine Learning-I	4

Prerequisite: Linear Algebra, Probability & Statistics, and Programming (preferably Python)	
Course Objectives:	
1	To introduce students to the foundational concepts and techniques of machine learning.
2	To develop an understanding of supervised and unsupervised learning algorithms and their applications.
3	To equip students with skills to preprocess data and evaluate machine learning models effectively.
4	To provide hands-on experience in implementing basic ML algorithms using Python.
5	To explore the mathematical underpinnings of machine learning techniques for better comprehension.
Course Outcomes:	
1	Explain the principles and types of machine learning (supervised, unsupervised).
2	Implement and tune basic ML algorithms like regression, classification, and clustering.
3	Preprocess datasets and select appropriate features for model training.
4	Evaluate model performance using metrics like accuracy, precision, and RMSE.
5	Apply machine learning techniques to solve simple real-world problems.

Module		Content	Hrs
1		**Introduction to Machine Learning**	**8**
	1.1	Overview of Machine Learning: Definition, Types (Supervised, Unsupervised, Reinforcement).	
	1.2	Applications of ML: Healthcare, Finance, Image Recognition.	
	1.3	ML Workflow: Data Collection, Preprocessing, Model Training, Evaluation.	
	1.4	Tools and Libraries: Python, NumPy, Pandas, Scikit-Learn.	
2		**Mathematical Foundations**	**8**
	2.1	Linear Algebra: Vectors, Matrices, Eigenvalues.	
	2.2	Probability and Statistics: Distributions, Expectation, Variance.	
	2.3	Optimization: Gradient Descent, Cost Functions.	
	2.4	Bias-Variance Tradeoff and Overfitting.	
3		**Supervised Learning - Regression**	**7**
	3.1	Linear Regression: Simple and Multiple Regression.	
	3.2	Cost Function and Gradient Descent Optimization.	
	3.3	Polynomial Regression and Feature Scaling.	
	3.4	Evaluation Metrics: Mean Squared Error (MSE), R-squared.	

4		**Supervised Learning - Classification**	**7**
	4.1	Logistic Regression: Binary and Multiclass Classification.	
	4.2	Decision Trees: Construction and Pruning.	
	4.3	K-Nearest Neighbors (KNN): Distance Metrics and Algorithm.	
	4.4	Evaluation Metrics: Accuracy, Precision, Recall, F1-Score.	
5		**Unsupervised Learning**	**7**
	5.1	Clustering: K-Means, Hierarchical Clustering.	
	5.2	Dimensionality Reduction: Principal Component Analysis (PCA).	
	5.3	Distance Measures: Euclidean, Manhattan.	
	5.4	Evaluation: Silhouette Score, Elbow Method.	
6		**Model Evaluation and Preprocessing**	**8**
	6.1	Data Preprocessing: Handling Missing Values, Normalization, Encoding.	
	6.2	Train-Test Split and Cross-Validation.	
	6.3	Hyperparameter Tuning: Grid Search, Random Search.	
	6.4	Practical Implementation: Building an End-to-End ML Pipeline.	
Total			**45**

Textbooks:	
1	"Machine Learning" by Dr. Vinod Chandra S.S. and Anand Hareendran S., PHI Learning (India).
2	"Introduction to Machine Learning" by P. K. Das, Wiley India
3	"Machine Learning" by Tom M. Mitchell, McGraw Hill
References:	
1	"Pattern Recognition and Machine Learning" by Christopher M. Bishop, Springer
2	"The Elements of Statistical Learning" by Trevor Hastie, Robert Tibshirani, and Jerome Friedman,Springer
Useful Links for E-resources:	
1	http://cs229.stanford.edu
2	https://machinelearningmastery.com/machine-learning-in-python-step-by-step/
3	https://towardsdatascience.com/beginners-guide-to- machine-learning-with-python-b9ff35bc9c51
4	https://nptel.ac.in/courses/106106145

<u>Assessment</u>:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks

3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lectures hours as mention in the syllabus.

List of Practical/ Experiments:

Sr. No	Topic
1	Load a dataset (e.g., Iris), visualize distributions, and handle missing values using Python.
2	Code linear regression using gradient descent and evaluate with MSE on a housing dataset.
3	Predict a continuous variable (e.g., sales) using multiple features and analyze R-squared.
4	Classify a dataset (e.g., Titanic survival) and compute accuracy, precision, and recall.
5	Implement KNN on a dataset (e.g., digits) and experiment with different k values.
6	Build a decision tree for a dataset (e.g., wine quality) and visualize the tree structure.
7	Cluster a dataset (e.g., customer data) and determine the optimal number of clusters using the elbow method.
8	Reduce dimensions of a dataset (e.g., MNIST) and visualize the results in 2D.
9	Normalize, encode, and split a dataset (e.g., credit card data) for ML model training.
10.	Apply k-fold cross-validation on a regression/classification model and compare scores.
11	Tune parameters of a KNN or decision tree model on a dataset.
12	Build a pipeline (preprocessing, model training, evaluation) for a real-world problem (e.g., predicting house prices).

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of “Software Engineering”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus.

Course Code	Course Name	Credit
22505	**Cloud Network and Security**	4

Prerequisite: Computer Networks and Operating Systems.	
Course Objectives:	
1	To introduce students to the fundamentals of cloud computing and its network architecture.
2	To develop an understanding of cloud deployment models, services, and their security implications.
3	To equip students with skills to design and manage secure cloud networks.
4	To explore advanced cloud security mechanisms, including encryption and intrusion detection.
5	To provide hands-on experience with cloud platforms and security tools.
Course Outcome:	
1	Explain the architecture and components of cloud networks.
2	Design and configure cloud-based networks using virtualization and SDN.
3	Implement security measures to protect cloud infrastructure and data.
4	Evaluate the performance and security of cloud services using standard metrics.
5	Deploy and manage a secure cloud application using a popular cloud platform.

Module		Detailed Content	Hours
1		**Introduction to Cloud Computing**	
	1.1	Overview of Cloud Computing: Definition, Characteristics, Benefits.	**8**
	1.2	Cloud Service Models: IaaS, PaaS, SaaS.	
	1.3	Cloud Deployment Models: Public, Private, Hybrid, Community.	
	1.4	Virtualization Basics: Hypervisors, Containers.	
2		**Cloud Network Architecture**	**8**
	2.1	Cloud Networking Fundamentals: Virtual Networks, Subnets.	
	2.2	Software-Defined Networking (SDN) in Cloud.	
	2.3	Network Function Virtualization (NFV).	
	2.4	Load Balancing and Traffic Management in Cloud.	
3		**Cloud Storage and Data Management**	**8**
	3.1	Cloud Storage Types: Block, Object, File Storage.	
	3.2	Data Replication and Consistency Models.	
	3.3	Distributed File Systems: Hadoop DFS, Amazon S3.	
	3.4	Backup and Disaster Recovery in Cloud.	
4		**Cloud Security Fundamentals**	**6**

	4.1	Security Challenges in Cloud: Threats, Vulnerabilities.	
	4.2	Authentication and Access Control: IAM, OAuth.	
	4.3	Data Encryption: At Rest and In Transit.	
	4.4	Compliance Standards: GDPR, HIPAA, ISO 27001	
5		**Advanced Cloud Security Techniques**	**8**
	5.1	Intrusion Detection and Prevention Systems (IDPS) in Cloud.	
	5.2	Firewall Configuration and Security Groups.	
	5.3	Secure API Design and Management.	
	5.4	Cloud Security Monitoring: Logging, Auditing	
6		**Cloud Platforms and Deployment**	7
	6.1	Popular Cloud Platforms: AWS, Azure, Google Cloud.	
	6.2	Deploying Applications on Cloud: VM Instances, Containers.	
	6.3	Performance Optimization: Auto-Scaling, Resource Allocation.	
	6.4	Case Studies: Real-World Cloud Security Breaches.	
Total			**45**

Textbooks:	
1	"Cloud Computing" by Dr. K. Adisesha and Dr. R. Venkatesh, S. Chand Publishing
2	"Cloud Security" by Dr. Sunita Vikrant Dhavale, Wiley India
3	"Cloud Computing: Concepts, Technology & Architecture" by Thomas Erl, Ricardo Puttini, and Zaigham Mahmood, O'Reilly Media
References:	
1	"Mastering Cloud Computing" by Rajkumar Buyya, Christian Vecchiola, and S. Thamarai Selvi, McGraw Hill
2	"Network Security Essentials" by William Stallings, Pearson

Assessment:
Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Useful Links	
1	https://aws.amazon.com/training/
2	https://learn.microsoft.com/en-us/training/
3	https://www.cloudskillsboost.google/

List of Practical/ Experiments:

Sr. No	Topic
1	Configure a VPC with subnets and routing tables on AWS or Azure.
2	Launch a simple web server (e.g., Apache) on an EC2 instance or Google Compute Engine.
3	Set up a load balancer to distribute traffic across multiple cloud instances.
4	Encrypt data at rest using AWS S3 or Azure Blob Storage and test decryption.
5	Create and manage user roles and permissions using Identity Access Management.
6	Set up security groups or network ACLs to restrict traffic to a cloud VM.
7	Use AWS CloudWatch or Azure Monitor to track CPU usage and set alerts.
8	Deploy a containerized application on a cloud platform using Docker and Kubernetes.
9	Simulate a basic DDoS attack and configure mitigation using cloud security tools.
10.	Design and deploy a secure cloud application with encryption, IAM, and monitoring.

Course Code	Course Name	Credits
22506	Big Data Analytics	4

Prerequisite: Database Management Systems and Basic Programming (preferably Python or Java).	
Course Objectives:	
1	To introduce students to the concepts, challenges, and technologies of big data analytics.
2	To develop skills in processing and analyzing large datasets using distributed computing frameworks.
3	To explore data storage and management techniques for big data environments.
4	To provide hands-on experience with big data tools like Hadoop, Spark, and NoSQL databases.
5	To examine real-world applications of big data analytics in various domains.
Course Outcomes:	
1	Students will be able to explain the characteristics and architecture of big data systems..
2	Implement data processing pipelines using Hadoop and Spark for large datasets.
3	Design and query NoSQL databases for unstructured and semi-structured data.
4	Analyze big data using statistical and machine learning techniques.
5	Apply big data analytics to solve real-world problems in business or science.

Module	Detailed Contents		Hours
1	**Introduction to Big Data**		7
	1.1	Big Data Overview: Definition, 5 Vs (Volume, Velocity, Variety, Veracity, Value)	
	1.2	Challenges in Big Data: Storage, Processing, Analysis.	
	1.3	Big Data Ecosystem: Tools and Technologies Overview	
	1.4	Applications: Healthcare, Finance, Social Media Analytics	
2	**Big Data Storage and Management**		7
	2.1	Distributed File Systems: Hadoop Distributed File System (HDFS)	
	2.2	NoSQL Databases: Key-Value (Redis), Document (MongoDB), Column-Family (Cassandra).	
	2.3	Data Warehousing: Concepts and Architectures	
	2.4	Data Ingestion: Batch vs. Real-Time Processing	
3	**Distributed Computing Frameworks**		8
	3.1	Hadoop Ecosystem: HDFS, MapReduce, YARN	

	3.2	Programming with MapReduce: Basics and Examples.	
	3.3	Apache Spark: Architecture, RDDs, DataFrames.	
	3.4	Spark SQL and Streaming: Querying and Real-Time Data.	
4	**Data Processing and Analytics**		8
	4.1	Data Preprocessing: Cleaning, Transformation, Integration.	
	4.2	Statistical Analysis: Descriptive and Inferential Statistics.	
	4.3	Machine Learning on Big Data: Classification, Clustering, Regression.	
	4.4	Visualization Tools: Tableau, Power BI Integration.	
5	**Advanced Big Data Techniques**		8
	5.1	Stream Processing: Apache Kafka, Spark Streaming	
	5.2	Graph Analytics: Apache Giraph, Neo4j	
	5.3	Time Series Analysis: Forecasting with Big Data	
	5.4	Cloud-Based Big Data Solutions: AWS EMR, Google BigQuery	
6	**Big Data Applications and Deployment**		7
	6.1	Case Studies: Recommendation Systems, Fraud Detection	
	6.2	Scalability and Performance Optimization	
	6.3	Security and Privacy in Big Data	
	6.4	Deploying a Big Data Analytics Pipeline: End-to-End Workflow	
Total			45

Textbooks:	
1	"Big Data Analytics" by Dr. R.N. Behera and Dr. S.K. Jena, Wiley India
2	"Big Data: Principles and Best Practices of Scalable Real-Time Data Systems" by Nathan Marz and James Warren, Manning Publications
3	"Hadoop: The Definitive Guide" by Tom White, O'Reilly Media
4	"Big Data and Hadoop" by V.K. Jain, Khanna Publishing
References:	
1	"Big Data Analytics with Spark" by Mohammed Guller, Apress
2	"Data Science and Big Data Analytics" by EMC Education Services, Wiley
3	"NoSQL Distilled" by Pramod J. Sadalage and Martin Fowler, Addison-Wesley

Useful Links	
1	https://www.edx.org
2	https://hadoop.apache.org/docs/
3	https://archive.nptel.ac.in/courses/106/105/106105084/

Internal Assessment Test:

The assessment consists of two class tests of 20 marks each. The 1st class test (Internal Assessment I) has to be conducted when approximately 40% of the syllabus is completed. The 2nd class test has to be conducted (Internal Assessment II) when an additional 40% syllabus is Completed. The duration of each test will be for one hour.	
End Semester Theory Examination:	
1	The question paper will comprise a total of 6 questions, each carrying 20 marks.
2	Out of the 6 questions, 4 questions have to be attempted.
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	In question paper weightage of each module will be proportional to number of respectivelecture hours as mentioned in the syllabus.

Suggested List of Practical/ Experiments:

Practical Number	Practical/ Experiment
1	Install Hadoop and store a large dataset (e.g., logs) in HDFS.
2	Write a MapReduce program in Java or Python to count words in a text corpus.
3	Use Apache Spark to process a dataset (e.g., movie ratings) with RDD operations.
4	Load a CSV dataset into Spark and run SQL queries to extract insights.
5	Store and query JSON data (e.g., social media posts) using MongoDB.
6	Set up Kafka to stream and process live data (e.g., sensor readings).
7	Apply K-Means clustering on a large dataset (e.g., customer purchases).
8	Build and query a graph database for a social network dataset.
9	Connect a big data source (e.g., Spark) to Tableau and create dashboards.
10	Design a pipeline to ingest, process, and analyze a dataset (e.g., e-commerce transactions) using Hadoop and Spark.

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of “Software Engineering”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus.

Course Code:	Course Title	Credit
22507	Major Project-I (Cloud Computing or Big Data)	**4**

Assessment:
Internal Assessment:
Term Work marks 50 are based on Two Project Reviews and Final Presentation. Project should done based on Subjects learned in the Syllabus.
End Theory Examination: No Practical and Oral Examinations

Program Structure for Third Year Big Database and Cloud Computing

UNIVERSITY OF MUMBAI (With Effect from 2023-2024)
Semester VI

Course Code:	Course Title	Credit
22601	Professional Skill-VI (Cloud Computing using any one platform AWS, Azure, etc)	**4**

Prerequisite: Basic Computer Networks and Operating Systems	
Course Objectives:	
1	To introduce students to the fundamentals of cloud computing using a specific platform (e.g., AWS).
2	To develop practical skills in deploying and managing cloud-based applications.
3	To equip students with the ability to configure cloud resources like compute, storage, and networking.
4	To provide hands-on experience with cloud security and monitoring tools.
5	To prepare students for professional cloud certifications (e.g., AWS Certified Solutions Architect).
Course Outcomes:	
1	Describe the architecture and services of a chosen cloud platform (e.g., AWS).
2	Deploy and manage virtual machines, storage, and networking in the cloud.
3	Implement basic security measures to protect cloud resources.
4	Monitor and optimize cloud applications using platform-specific tools.
5	Design and deploy a simple cloud-based solution for a real-world scenario.

Module		Content	Hrs
1		**Introduction to Cloud Computing and AWS. (Using AWS as the example platform; can be adapted for Azure or others)**	**8**
	1.1	Cloud Computing Basics: Definition, Service Models (IaaS, PaaS, SaaS).	
	1.2	AWS Overview: Global Infrastructure, Core Services (EC2, S3, VPC).	
	1.3	AWS Free Tier: Account Setup and Navigation.	
	1.4	Use Cases: Web Hosting, Data Backup, App Development.	
2		**Compute Services in AWS**	**7**
	2.1	Amazon EC2: Launching and Managing Virtual Machines.	
	2.2	Instance Types and AMIs (Amazon Machine Images).	
	2.3	Auto Scaling: Dynamic Resource Allocation.	
	2.4	AWS Lambda: Serverless Computing Basics.	
3		**Storage and Database Services**	**7**
	3.1	Amazon S3: Object Storage Setup and Management.	
	3.2	Elastic Block Store (EBS): Block Storage for EC2.	

	3.3	Amazon RDS: Relational Database Deployment	
	3.4	DynamoDB: NoSQL Database Basics	
4		**Networking in AWS**	**8**
	4.1	Virtual Private Cloud (VPC): Subnets, Gateways, Routing.	
	4.2	Elastic Load Balancer (ELB): Traffic Distribution.	
	4.3	Route 53: DNS Configuration and Domain Management.	
	4.4	CloudFront: Content Delivery Network Basics.	
5		**Security and Monitoring**	**7**
	5.1	Identity and Access Management (IAM): Users, Roles, Policies.	
	5.2	Security Groups and Network ACLs: Firewall Setup.	
	5.3	AWS CloudWatch: Monitoring Metrics and Logs.	
	5.4	AWS Key Management Service (KMS): Encryption Basics.	
6		**Application Deployment and Best Practices**	**8**
	6.1	Deploying a Web Application: EC2, S3, RDS Integration.	
	6.2	Infrastructure as Code: AWS CloudFormation Basics.	
	6.3	Cost Management: Budgets and Billing Dashboard.	
	6.4	Project: End-to-End Cloud Solution (e.g., E-commerce Site).	
Total			**45**

Textbooks:	
1	"Cloud Computing" by Dr. K. Adisesha and Dr. R. Venkatesh, S. Chand Publishing
2	"Cloud Security" by Dr. Sunita Vikrant Dhavale, Wiley India
3	"Cloud Computing: Concepts, Technology & Architecture" by Thomas Erl, Ricardo Puttini, and Zaigham Mahmood, O'Reilly Media
References:	
1	"Mastering Cloud Computing" by Rajkumar Buyya, Christian Vecchiola, and S. Thamarai Selvi, McGraw Hill
2	"AWS Certified Solutions Architect Study Guide" by Ben Piper and David Clinton, Sybex

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 10 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.

2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Useful Links	
1	https://aws.amazon.com/training/
2	https://www.qwiklabs.com/

List of Tutorial:

Tutorial Number	**Tutorial Topic**
1	Launching an EC2 Instance
2	Storing Files in Amazon S3
3	Deploying a Static Website on S3
4	Serverless Function with AWS Lambda
5	Building a Simple Cloud App

Course Code:	**Course Title**	**Credit**
22602	**Environment Management**	**4**

Prerequisite: Basic Environmental Science or General Science	
Course Objectives:	
1	To introduce students to the principles and practices of environmental management.
2	To develop an understanding of ecological systems and their interaction with human activities.
3	To equip students with skills to assess and mitigate environmental impacts.
4	To explore sustainable development strategies and environmental policies.
5	To provide practical experience in environmental monitoring and management techniques.
Course Outcomes:	
1	Students will be able to explain key concepts and frameworks of environmental management.
2	Assess environmental risks and propose mitigation strategies.
3	Apply tools and techniques to monitor environmental quality (e.g., air, water).
4	Evaluate the effectiveness of environmental policies and sustainability initiatives.
5	Design a basic environmental management plan for a real-world scenario.

Module		**Content**	**Hrs**

1		**Introduction to Environment Management**	**8**
	1.1	Overview of Environment Management: Definition, Scope, Importance.	
	1.2	Ecosystems: Structure, Function, and Services.	
	1.3	Human-Environment Interaction: Impacts and Challenges.	
	1.4	Sustainable Development: Principles and Goals (SDGs).	
2		**Environmental Resources and Conservation**	**7**
	2.1	Natural Resources: Renewable vs. Non-Renewable.	
	2.2	Water Resource Management: Conservation and Pollution Control.	
	2.3	Land and Soil Management: Degradation, Restoration.	
	2.4	Biodiversity Conservation: Strategies and Threats.	
3		**Environmental Pollution and Control**	**7**
	3.1	Types of Pollution: Air, Water, Soil, Noise.	
	3.2	Pollution Sources and Effects: Industrial, Agricultural, Urban.	
	3.3	Pollution Control Technologies: Waste Treatment, Emission Reduction.	
	3.4	Case Studies: Successful Pollution Mitigation Projects.	
4		**Environmental Impact Assessment (EIA)**	**8**
	4.1	EIA Process: Screening, Scoping, Impact Analysis.	
	4.2	Tools and Methods: Checklists, Matrices, GIS	
	4.3	Mitigation Measures and Monitoring Plans.	
	4.4	Legal Frameworks: EIA Regulations in India and Globally.	
5		**Environmental Policy and Legislation**	**7**
	5.1	Environmental Laws: National (e.g., EPA India) and International (e.g., Paris Agreement).	
	5.2	Policy Instruments: Taxes, Subsidies, Cap-and-Trade.	
	5.3	Role of Organizations: UNEP, IPCC, NGOs.	
	5.4	Corporate Social Responsibility (CSR) in Environment Management.	
6		**Practical Applications and Sustainability**	**8**
	6.1	Environmental Monitoring: Sampling, Data Collection (Air/Water Quality).	
	6.2	Waste Management: Recycling, Composting, Hazardous Waste.	
	6.3	Green Technologies: Renewable Energy, Eco-Friendly Practices.	
	6.4	Project: Designing an Environmental Management Plan.	
Total			**45**

Textbooks:

1	"Environmental Management" by Dr. S.K. Dhameja, S.K. Kataria & Sons
2	"Textbook of Environmental Studies" by Erach Bharucha, Universities Press (India)
3	"Environmental Management: Readings and Case Studies" by Lewis Owen and Tim Unwin, Wiley-Blackwell

References:

1	"Environmental Management for Sustainable Development" by Chris Barrow, Routledge
2	"Introduction to Environmental Management" by Mary K. Theodore and Louis Theodore, CRC Press

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 10 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Useful Links	
1	https://www.unep.org
2	https://olc.worldbank.org/

List of Tutorial:

Tutorial Number	**Tutorial Topic**
1	Use maps or GIS tools to analyze a local ecosystem and its components.
2	Water Quality Testing
3	Air Pollution Monitoring
4	Simulate waste sorting and calculate recycling potential for a small community.
5	Carbon Footprint Calculation

Course Code:	**Course Title**	**Credit**

22603	Internet of Things	4

Prerequisite: Basic Electronics and Computer Networks.	
Course Objectives:	
1	To introduce students to the concepts, architecture, and applications of the Internet of Things.
2	Develop skills in designing and programming IoT devices using sensors and microcontrollers.
3	Explore communication protocols and networking technologies for IoT systems.
4	Provide hands-on experience with IoT platforms and cloud integration.
5	Examine security, privacy, and real-world deployment challenges in IoT.
Course Outcomes:	
1	Students will be able to explain the components and architecture of IoT systems.
2	Design and implement IoT solutions using hardware and software tools.
3	Configure IoT devices to communicate over networks using standard protocols.
4	Integrate IoT devices with cloud platforms for data storage and analysis.
5	Evaluate security risks and propose mitigation strategies for IoT applications.

Module		Content	Hrs
1		**Introduction to IoT**	**8**
	1.1	IoT Overview: Definition, Characteristics, Evolution.	
	1.2	IoT Architecture: Sensors, Gateways, Cloud.	
	1.3	Applications: Smart Homes, Healthcare, Agriculture.	
	1.4	IoT Ecosystem: Hardware, Software, Connectivity.	
2		**IoT Hardware and Sensors**	**8**
	2.1	Microcontrollers: Arduino, Raspberry Pi, ESP32.	
	2.2	Sensors: Temperature, Humidity, Motion, Light.	
	2.3	Actuators: Relays, Motors, LEDs.	
	2.4	Interfacing: Analog and Digital I/O.	
3		**IoT Communication Protocols**	**7**
	3.1	Wired Protocols: UART, I2C, SPI.	
	3.2	Wireless Protocols: Wi-Fi, Bluetooth, Zigbee, LoRa.	
	3.3	IoT-Specific Protocols: MQTT, CoAP, HTTP.	
	3.4	Network Topologies: Star, Mesh.	
4		**IoT Programming and Development**	**8**
	4.1	Programming IoT Devices: Arduino IDE, Python.	
	4.2	Data Acquisition and Processing: Sensor Data Handling.	
	4.3	Embedded Systems Basics: Firmware Development.	
	4.4	Simulation Tools: Tinkercad, Proteus.	

5		**IoT Cloud Integration**	**7**
	5.1	Cloud Platforms: AWS IoT, Azure IoT, Google Cloud IoT.	
	5.2	Data Transmission: Publishing and Subscribing (MQTT).	
	5.3	Data Storage and Visualization: Databases, Dashboards.	
	5.4	Edge Computing: Local Processing vs. Cloud.	
6		**IoT Security and Applications**	**8**
	6.1	Security Challenges: Authentication, Encryption.	
	6.2	IoT Security Mechanisms: TLS, Device Identity.	
	6.3	Case Studies: Smart Cities, Industrial IoT.	
	6.4	Project: Designing an IoT Solution (e.g., Smart Irrigation).	
Total			**45**

Textbooks:	
1	"Internet of Things" by Dr. Jeeva Jose, Khanna Publishing
2	"IoT: Concepts and Applications" by Raj Kamal, McGraw Hill Education (India)
3	"Internet of Things: Principles and Paradigms" by Rajkumar Buyya and Amir Vahid Dastjerdi, Morgan Kaufmann
References:	
1	"The Internet of Things" by Samuel Greengard, MIT Press
2	"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases" by David Hanes et al., CISCO Press
Useful Links for E-resources:	
1	https://aws.amazon.com/iot/
2	https://www.edx.org/iot

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lectures hours as mention in the syllabus.

List of Practical/ Experiments:

Sr. No	Topic

1	LED Control with Arduino- Program an Arduino to blink an LED based on a button press.
2	Use a DHT11 sensor with Raspberry Pi to measure and display temperature.
3	Send sensor data (e.g., light intensity) from ESP32 to a local server via Wi-Fi.
4	Set up an MQTT broker and publish/subscribe sensor data using Python.
5	Control a relay (e.g., light switch) with Arduino and a mobile app via Bluetooth.
6	Cloud Data Logging- Upload temperature data to AWS IoT Core and visualize it in a dashboard.
7	Use a PIR sensor with Raspberry Pi to send an email alert on motion detection.
8	Build a station with sensors (temperature, humidity) and display data on a web page.
9	Implement TLS encryption for data transmission between an IoT device and cloud.
10.	Design an IoT system to monitor soil moisture and control a water pump.

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of "Software Engineering"
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus.

Course Code:	**Course Title**	**Credit**
22604	**Cyber Security**	**4**

Prerequisite: Computer Networks and Operating Systems.	
Course Objectives:	
1	To introduce students to the fundamentals of cyber security and its importance in the digital world.
2	Develop skills in identifying and mitigating common cyber threats and vulnerabilities.
3	Explore cryptographic techniques and their applications in securing data and communications.
4	Provide hands-on experience with security tools for network and system protection.
5	Examine legal, ethical, and professional aspects of cyber security.
Course Outcomes:	
1	Students will be able to explain key concepts and principles of cyber security.
2	Implement encryption and authentication mechanisms to secure data.

3	Identify and analyze cyber threats and vulnerabilities in systems and networks.
4	Use security tools to monitor and defend against cyber attacks.
5	Develop a basic incident response plan for a cyber security breach.

Module		Content	Hrs
1		**Introduction to Cyber Security**	**8**
	1.1	Cyber Security Overview: Definition, Need, and Scope.	
	1.2	Types of Threats: Malware, Phishing, DDoS, Insider Threats.	
	1.3	Security Principles: Confidentiality, Integrity, Availability (CIA Triad).	
	1.4	Cyber Security Landscape: Attackers, Defenders, Tools.	
2		**Network Security Fundamentals**	**8**
	2.1	Network Vulnerabilities: Packet Sniffing, Spoofing.	
	2.2	Firewalls: Types, Configuration, Limitations.	
	2.3	Intrusion Detection Systems (IDS): Signature vs. Anomaly-Based.	
	2.4	VPNs and Secure Communication: Basics and Setup.	
3		**Cryptography and Secure Systems**	**7**
	3.1	Cryptography Basics: Symmetric vs. Asymmetric Encryption.	
	3.2	Algorithms: AES, RSA, Hashing (SHA, MD5).	
	3.3	Public Key Infrastructure (PKI): Certificates, Digital Signatures.	
	3.4	Secure Protocols: SSL/TLS, HTTPS, IPsec.	
4		**Cyber Threats and Defenses**	**8**
	4.1	Malware Analysis: Viruses, Worms, Trojans, Ransomware.	
	4.2	Penetration Testing: Tools (e.g., Metasploit), Methodology.	
	4.3	Social Engineering: Phishing Attacks and Prevention.	
	4.4	Defense Mechanisms: Antivirus, Endpoint Security.	
5		**System and Application Security**	**7**
	5.1	Operating System Security: Hardening Techniques.	
	5.2	Web Security: SQL Injection, XSS, CSRF.	
	5.3	Access Control: Authentication (e.g., MFA), Authorization.	
	5.4	Secure Software Development: OWASP Guidelines.	
6		**Incident Response and Cyber Law**	**8**
	6.1	Incident Response: Detection, Containment, Recovery.	
	6.2	Forensics Basics: Evidence Collection, Log Analysis.	
	6.3	Cyber Laws: IT Act (India), GDPR, HIPAA.	
	6.4	Ethical Hacking: Principles and Legal Considerations.	
Total			**45**

Textbooks:	
1	"Cyber Security" by Nina Godbole and Sunit Belapure, Wiley India
2	"Fundamentals of Cyber Security" by Mayank Bhushan, BPB Publications
3	"Cybersecurity Essentials" by Charles J. Brooks et al., Sybex
References:	
1	"Network Security Essentials" by William Stallings, Pearson
2	"The Web Application Hacker's Handbook" by Dafydd Stuttard and Marcus Pinto, Wiley
Useful Links for E-resources:	
1	https://www.cybrary.it
2	https://owasp.org

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lectures hours as mention in the syllabus.

List of Practical/ Experiments:

Sr. No	Topic
1	Use Wireshark to capture and analyze network traffic on a local network.
2	Set up a basic firewall using iptables or Windows Defender Firewall.
3	Encrypt and decrypt a file using AES with Python or OpenSSL.
4	Analyze phishing emails and create a mock phishing page to understand tactics.
5	Create a harmless script to simulate malware behavior and detect it with antivirus.
6	Use Metasploit to scan and exploit a virtual machine (e.g., Metasploitable).
7	Scan a test website for SQL injection or XSS using Burp Suite or OWASP ZAP.
8	Set up an SFTP server and transfer files securely using SSH.
9	Analyze system logs (e.g., from a Linux server) to identify suspicious activity.

10.	Create a dashboard to monitor network traffic or system events using open-source tools.

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of "Software Engineering"
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus.

Course Code:	Course Title	Credit
22605	**Distributed Computing**	**4**

Prerequisite: Computer Networks and Operating Systems.	
Course Objectives:	
1	To introduce students to the concepts and architectures of distributed computing systems.
2	Develop an understanding of communication, synchronization, and coordination in distributed environments.
3	Equip students with skills to design and implement distributed applications.
4	Explore fault tolerance and scalability in distributed systems.
5	Provide hands-on experience with distributed computing frameworks and tools.
Course Outcomes:	
1	Students will be able to explain the characteristics and models of distributed systems.
2	Implement inter-process communication and synchronization mechanisms.
3	Design distributed algorithms for real-world applications.
4	Evaluate the performance and reliability of distributed systems.
5	Develop a distributed application using modern tools or frameworks.

Module		Content	Hrs
1		**Introduction to Distributed Computing**	**8**
	1.1	Distributed Systems: Definition, Goals, Challenges.	
	1.2	Characteristics: Concurrency, Scalability, Fault Tolerance.	
	1.3	Architectures: Client-Server, Peer-to-Peer, Multi-Tier.	
	1.4	Examples: Cloud Computing, Blockchain, CDN.	
2		**Communication in Distributed Systems**	**8**
	2.1	Inter-Process Communication (IPC): Message Passing, RPC.	
	2.2	Middleware: CORBA, RMI, gRPC.	

	2.3	Network Protocols: TCP/IP, UDP, Sockets.	
	2.4	Time and Clock Synchronization: Lamport Clocks, NTP.	
3		**Synchronization and Coordination**	**7**
	3.1	Mutual Exclusion: Centralized, Distributed Algorithms.	
	3.2	Election Algorithms: Bully, Ring.	
	3.3	Deadlock Detection and Prevention in Distributed Systems.	
	3.4	Consistency Models: Eventual, Strong, Causal.	
4		**Distributed Algorithms**	**8**
	4.1	Distributed Consensus: Paxos, Raft.	
	4.2	Leader Election and Replication.	
	4.3	Distributed Transactions: Two-Phase Commit (2PC).	
	4.4	Load Balancing: Round-Robin, Least Connection.	
5		**Fault Tolerance and Recovery**	**7**
	5.1	Fault Models: Crash, Byzantine Failures.	
	5.2	Replication Techniques: Primary-Backup, Active Replication.	
	5.3	Checkpointing and Rollback Recovery.	
	5.4	Distributed File Systems: NFS, GFS.	
6		**Distributed Computing Frameworks and Applications**	**8**
	6.1	Frameworks: Apache Hadoop, Spark, MPI.	
	6.2	Cloud-Based Distributed Systems: AWS Lambda, Azure Functions.	
	6.3	Security in Distributed Systems: Authentication, Encryption.	
	6.4	Project: Building a Distributed Application (e.g., Chat System).	
Total			**45**

Textbooks:	
1	"Distributed Computing" by Sunita Mahajan and Seema Shah, Oxford University Press (India)
2	"Distributed Systems" by Dr. R.K. Singla, S.K. Kataria & Sons
3	"Distributed Systems: Concepts and Design" by George Coulouris, Jean Dollimore, and Tim Kindberg, Pearson
References:	
1	"Distributed Systems: Principles and Paradigms" by Andrew S. Tanenbaum and Maarten Van Steen, Pearson
2	"Designing Data-Intensive Applications" by Martin Kleppmann, O'Reilly Media
Useful Links for E-resources:	
1	https://ocw.mit.edu
2	https://hadoop.apache.org/docs/

Assessment:

Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lectures hours as mention in the syllabus.

List of Practical/ Experiments:

Sr. No	Topic
1	Implement a simple client-server chat application using TCP sockets in Python.
2	Use gRPC or Java RMI to create a distributed calculator service.
3	Simulate Lamport's logical clocks in a multi-process system.
4	Implement the Ricart-Agrawala algorithm for mutual exclusion in Python.
5	Code the Bully algorithm to elect a leader among distributed nodes.
6	Build a basic file-sharing system using sockets or a P2P framework.
7	Write a MapReduce program in Hadoop to count words in a large text file.
8	Use Apache Spark to process a dataset (e.g., movie ratings) and compute averages.
9	Simulate node failures in a distributed system and implement recovery.
10.	Develop a real-time chat system using a distributed framework (e.g., MPI or Spark).

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of "Software Engineering"
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus.

Course Code:	Course Title	Credit
22606	Machine Learning-II	4

Prerequisite: Machine Learning Part-1 or equivalent (Supervised/Unsupervised Learning, Python proficiency).	
Course Objectives:	
1	To deepen students' understanding of advanced machine learning algorithms and techniques.
2	To introduce ensemble methods, neural networks, and reinforcement learning concepts.
3	To develop skills in handling complex datasets and optimizing ML models for real-world applications.
4	To provide hands-on experience with deep learning frameworks.
5	To explore ethical considerations and practical challenges in deploying machine learning systems.
Course Outcomes:	
1	Implement and compare advanced ML algorithms like ensemble methods and neural networks.
2	Design solutions for complex problems using dimensionality reduction and feature engineering.
3	Optimize and deploy ML models using modern frameworks and techniques.
4	Analyze the trade-offs and limitations of advanced ML approaches in practical scenarios.
5	Demonstrate an understanding of reinforcement learning and its applications.

Module		Content	Hrs
1		**Advanced Supervised Learning**	**8**
	1.1	Ensemble Methods: Bagging, Boosting (AdaBoost, Gradient Boosting).	
	1.2	Support Vector Machines (SVM): Kernels, Margin Maximization.	
	1.3	Regularization Techniques: L1 (Lasso), L2 (Ridge).	
	1.4	Evaluation: ROC Curves, AUC, Confusion Matrix Analysis.	
2		**Advanced Unsupervised Learning**	**8**
	2.1	Advanced Clustering: DBSCAN, Gaussian Mixture Models (GMM)	
	2.2	Dimensionality Reduction: t-SNE, UMAP.	
	2.3	Anomaly Detection: Isolation Forest, One-Class SVM.	
	2.4	Applications: Customer Segmentation, Fraud Detection.	
3		**Introduction to Neural Networks**	7
	3.1	Perceptrons and Multi-Layer Perceptrons (MLP).	
	3.2	Activation Functions: Sigmoid, ReLU, Tanh.	
	3.3	Backpropagation and Gradient Descent Variants (SGD, Adam).	
	3.4	Overfitting Prevention: Dropout, Weight Decay.	
4		**Deep Learning Basics**	**8**

	4.1	Convolutional Neural Networks (CNN): Architecture, Convolution Layers.	
	4.2	Recurrent Neural Networks (RNN): LSTM, GRU.	
	4.3	Frameworks: TensorFlow, PyTorch Introduction.	
	4.4	Applications: Image Classification, Time Series Prediction.	
5		**Reinforcement Learning Fundamentals**	**7**
	5.1	Markov Decision Processes (MDP): States, Actions, Rewards.	
	5.2	Q-Learning and Value Iteration.	
	5.3	Exploration vs. Exploitation: Epsilon-Greedy, UCB.	
	5.4	Practical Examples: Game Playing, Robotics.	
6		**Model Optimization and Deployment**	**8**
	6.1	Hyperparameter Tuning: Bayesian Optimization, Genetic Algorithms.	
	6.2	Model Interpretability: SHAP, LIME.	
	6.3	Deployment: Flask for ML APIs, Model Serving with Docker.	
	6.4	Ethical Issues: Bias, Fairness, Privacy in ML.	
Total			**45**

Textbooks:	
1	"Advanced Machine Learning" by Dr. Sunita Jahirabadkar and Dr. Parag Kulkarni, Wiley India.
2	"Machine Learning and Deep Learning" by Dr. S. Sridhar and Dr. M. Chandrasekaran,PHI Learning (India).
3	"Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, MIT Press
References:	
1	"Pattern Recognition and Machine Learning" by Christopher M. Bishop, Springer
2	"Reinforcement Learning: An Introduction" by Richard S. Sutton and Andrew G. Barto, MIT Press.
Useful Links for E-resources:	
1	http://cs231n.stanford.edu
2	https://machinelearningmastery.com/machine-learning-in-python-step-by-step/
3	https://towardsdatascience.com/beginners-guide-to- machine-learning-with-python-b9ff35bc9c51
4	https://nptel.ac.in/courses/106106145

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks

3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lectures hours as mention in the syllabus.

List of Practical/ Experiments:

Sr. No	Topic
1	Implement a random forest classifier on a dataset (e.g., spam detection) and analyze feature importance.
2	Use XGBoost to predict a target variable (e.g., customer churn) and tune hyperparameters.
3	Train an SVM with different kernels (linear, RBF) on a dataset (e.g., digits) and compare performance.
4	Detect outliers in a dataset (e.g., credit card fraud) and evaluate with precision-recall.
5	Apply t-SNE to visualize high-dimensional data (e.g., gene expression) in 2D/3D.
6	Implement an MLP in PyTorch/TensorFlow for a classification task (e.g., fashion MNIST).
7	Train a CNN on a small image dataset (e.g., CIFAR-10) and analyze accuracy.
8	Implement Q-learning to solve a grid-world problem or a game like Frozen Lake.
9	Use SHAP to explain predictions of a gradient boosting model on a dataset (e.g., loan approval).
10.	Create a REST API to serve predictions from a trained model (e.g., sentiment analysis).
11	Design and train a CNN or RNN for a real-world task (e.g., handwritten digit recognition).

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of “Software Engineering”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus.

Course Code:	Course Title	Credit

22607	**Major Project-II (Cloud Computing or Big Data)**	**4**

Assessment:
Internal Assessment:
Term Work marks 50 are based on Two Project Reviews and Final Presentation. Project should done based on Subjects learned in the Syllabus.
End Theory Examination: No Practical and Oral Examinations