AC: 11 July, 22
Item No: 6.57 (R)

UNIVERSITY OF MUMBAI

Revised Syllabus

For

Master of Engineering

Program: M. E. (Computer Engineering)

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from academic year 2022-23)

AC: 11 July, 22

Item No: 6.57 (R)

UNIVERSITY OF MUMBAI

Sr. No.	Heading	Particulars
1	Title of the Course	**Master of Engineering (Computer Engineering)**
2	Eligibility for Admission	**Ordinance O.5134**
3	Passing Marks	**45%**
4	No. of Years / Semesters	**4 semesters**
5	Level	**P.G**. / ~~U.G./ Diploma / Certificate~~
6	Pattern	~~Yearly~~ / **Semester**
7	Status	~~**New**~~ / Revised
8	To be implemented from Academic Year	**With effect from Academic Year: 2022-2023**

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
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Dr Anuradha Muzumdar
Dean
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Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 68, wherein focus is not only on providing knowledge but also on building skills, attitude and self-learning. Therefore, in the present curriculum skill based laboratories are made mandatory across all disciplines of engineering, which will definitely facilitate self-learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Master of Computer Engineering from the academic year 2022-23.

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Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self-learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 68, to provide opportunity of self-learning to learner. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

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Preface by Board of Studies in

Computer Engineering

Dear Students and Teachers, we, the members of Board of Studies Computer Engineering, are very happy to present Master of Computer Engineering syllabus effective from the Academic Year 2022-23. We are sure you will find this syllabus interesting, challenging, fulfil certain needs and expectations.

Computer Engineering is one of the most sought-after courses amongst engineering students. The syllabus needs revision in terms of preparing the student for the professional scenario relevant and suitable to cater the needs of industry in present day context. The syllabus focuses on providing a sound theoretical background as well as good practical exposure to students in the relevant areas. It is intended to provide a modern, industry-oriented education in Computer Engineering. It aims at producing trained professionals who can successfully acquainted with the demands of the industry worldwide. They obtain skills and experience in up-to-date the knowledge to analysis, design, implementation, validation, and documentation of computer software and systems.

The revised syllabus is finalized through a brain storming session attended by Heads of Departments or senior faculty from the Department of Computer Engineering of the affiliated Institutes of the Mumbai University. The syllabus falls in line with the objectives of affiliating University, AICTE, UGC, and various accreditation agencies by keeping an eye on the technological developments, innovations, and industry requirements.

The salient features of the revised syllabus are:

1. Reduction in credits to 68 is implemented to ensure that students have more time for extracurricular activities, innovations, and research.
2. The department Optional Courses will provide the relevant specialization within the branch to a student.
3. Introduction of Skill Based Lab to showcase their talent by doing innovative projects that strengthen their profile and increases the chance of employability.
4. Students are encouraged to take up part of course through MOOCs platform SWAYAM

We would like to place on record our gratefulness to the faculty, students, industry experts and stakeholders for having helped us in the formulation of this syllabus.

Board of Studies in Computer Engineering

Prof. Sunil Bhirud	: Chairman
Prof. Sunita Patil	: Member
Prof. Leena Ragha	: Member
Prof. Subhash Shinde	: Member
Prof. Meera Narvekar	: Member
Prof. Suprtim Biswas	: Member
Prof. Sudhir Sawarkar	: Member
Prof. Dayanand Ingle	: Member
Prof. Satish Ket	: Member

Program Structure for ME Computer Engineering, (Rev.2022)

University of Mumbai

Semester –I

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ME-CSC101	Algorithm & Complexity	03	---	---	03	---	---	03
ME-CSC102	Advance Computer Network and Design	03	---	---	03	---	---	03
ME-CSDLO-X	Department Level Optional Course-1	03	---	---	03	---	---	03
ME-CSDLO-X	Department Level Optional Course-2	03	---	---	03	---	---	03
ILO-I	Institute Level Optional Course-I	03	---	---	03	---	---	03
ME-CSL101	Computational Laboratory-I	--	02	--	01	---	--	01
ME-CSL102	Skill Based Lab-I	--	04	--	02	---	--	01
Total		15	06	--	18	--	--	18

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ME-CSC101	Algorithm & Complexity	20	20	20	80	3	--	---	100
ME-CSC102	Advance Computer Network and Design	20	20	20	80	3	--	---	100
ME-CSDLOX	Department Level Optional Course-1	20	20	20	80	3	--	---	100
ME-CSDLOX	Department Level Optional Course-2	20	20	20	80	3	--	---	100
ILO-I	Institute Level Optional Course-I	20	20	20	80	3	--	---	100
ME-CSL101	Computational Laboratory-I	---	---	---	----	----	25	25	50
ME-CSL102	Skill Based Lab-I	---	---	---	----	----	50	50	100
Total		100	100	100	400	----	75	75	650

Semester –I

Course Code	Department Level Optional Course-1	Course Code	Institute Level Optional Course-I
ME-CSDLO11	Logic & Automated Reasoning	ILO1011	Product Lifecycle Management
ME-CSDLO12	Database Systems: Design and Implementation	ILO1012	Reliability Engineering
ME-CSDLO13	Computational Intelligence	ILO1013	Management Information System
ME-CSDLO14	Modern Operating System	ILO1014	Design of Experiments
	Department Level Optional Course-2	ILO1015	Operation Research
ME-CSDLO15	Component Based System Design	ILO1016	Cyber Security and Laws
ME-CSDLO16	ICT for Social Cause	ILO1017	Disaster Management & Mitigation Measures
ME-CSDLO17	Internet of Everything	ILO1018	Energy Audit and Management
ME-CSDLO18	Web Application Security	ILO1019	Development Engineering

Program Structure for ME Computer Engineering, (Rev.2022)

University of Mumbai

Semester –II

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ME-CS201	Cloud Computing and Services	03	---	---	03	---	---	03
ME-CS202	Exploratory Data Analytics and Visualization	03	---	---	03	---	---	03
ME-CSDLO-X	Department Level Optional Course-3	03	---	---	03	---	---	03
ME-CSDLO-X	Department Level Optional Course-4	03	---	---	03	---	---	03
ILO-II	Institute Level Optional Course-II	03	---	---	03	---	---	03
ME-CSL201	Computational Laboratory-II	--	02	--	01	---	--	01
ME-CSL202	Skill Based Lab-II	--	04	--	02	---	--	02
Total		15	06	---	18	--	--	18

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ME-CSC201	Cloud Computing and Services	20	20	20	80	3	--	---	100
ME-CSC202	Exploratory Data Analytics and Visualization	20	20	20	80	3	--	---	100
ME-CSDLOX	Department Level Optional Course-3	20	20	20	80	3	--	---	100
ME-CSDLOX	Department Level Optional Course-4	20	20	20	80	3	--	---	100
ILO-II	Institute Level Optional Course-II	20	20	20	80	3	--	---	100
ME-CSL201	Computational Laboratory-II	---	---	---	---	----	25	25	50
ME-CSL202	Skill Based Lab-II	---	---	---	---	----	50	50	100
		100	100	100	400	----	75	75	650

Program Structure for ME Computer Engineering, (Rev.2022)

University of Mumbai

Semester –II

Course Code	Department Level Optional Course –3	Course Code	Institute Level Optional Course-II
ME-CSDLO21	Ethical Hacking & Digital Forensic	ILO2021	Project Management
ME-CSDLO22	Data Storage & Retrieval	ILO2022	Finance Management
ME-CSDLO23	Advance Soft Computing	ILO2023	Entrepreneurship Development and Management
ME-CSDLO24	Semantic Web & Social Network Analysis	ILO2024	Human Resource Management
	Department Level Optional Course –4	ILO2025	Professional Ethics and CSR
ME-CSDLO25	Blockchain Technology & Applications	ILO 2026	Research Methodology
ME-CSDLO26	Storage Area Network	ILO2027	IPR and Patenting
ME-CSDLO27	Design Thinking	ILO2028	Digital Business Management
ME-CSDLO28	Metaverse	ILO2029	Environmental Management

Program Structure for ME Computer Engineering, (Rev.2022)

University of Mumbai

Semester –III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ME-CSMP301	Major Project: Dissertation –I	--	20	--	--	10	--	10
Total		**00**	**20**	**--**	**00**	**10**	**--**	**10**

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)	Term Work	Pract/ Oral	Total
		Test-1	Test-2	Avg					
ME-CSMP301	Major Project: Dissertation –I	--	--	--	--	--	100	--	100
Total		**--**	**--**	**--**	**--**	--	**100**	**--**	**100**

Online Credit Courses

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ME-CSOCC301	Online Credit Course- I	--	--	--	--	--	--	3
ME-CSOCC301	Online Credit Course- II	--	--	--	--	--	--	3
Total		**--**	**--**	**--**	**00**	**00**	**00**	**06**

Note: It is mandatory to complete the Online Credit Courses (OCC) available on NPTEL / Swayam /MOOC or similar platform approved by university. The learner shall opt for one course each from OCC- I and OCC-II. These two courses shall be completed in any semester I or II or III, but not later end of the Semester III. The credits earned withOCC- I and OCC-II shall be accounted in the third semester grade-sheet. The learner shall be allowed to take up thesecourses from his or her institute or organization/ industry where his / her major project is carried out. The students shall complete the courses and shall qualify the exam conducted by the respective authorities/ instructor from the platform. The fees for any such courses and the corresponding examination shall be borne by the learner. University shall make a provision that credit earned with OCC-I and OCC-II shall be accounted in the third semester grade-sheetwith actual names of the courses.

Online Credit Course I: The learner shall opt for the course in the domain of Research Methodology **or** Research & Publication Ethics or IPR. The opted course shall be of 3 credits of equivalent number of weeks.

Online Credit Course II: The learner shall opt for the course recommended by Faculty Advisor/ Project Supervisor from the institute. The opted course shall be of 3 credits of equivalent number of weeks.

Semester –IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ME-ITMP401	Major Project: Dissertation –II	--	32	--	--	16	--	16
Total		**--**	**32**	**--**	**--**	**16**	**--**	**16**

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					
ME-ITMP401	Major Project: Dissertation –II	--	--	--	--	--	100	100	200
Total		**--**	**--**	**--**	**--**	**--**	**100**	**100**	**200**

Total Credits: 68

Note: The Dissertation submission shall not be permitted till the learner completes all the credit requirements of ME course.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ME-CSC101	Algorithm and Complexity	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Prerequisite: Engineering Mathematics, Data Structures, Algorithms	
Course Objectives:	
1	To analyze the algorithms using space and time complexity.
2	To teach problem formulation and problem solving skills.
3	To acquire knowledge of various applied algorithms.
4	To understand selected topics in algorithms that have found applications in areas such as geometric modelling, graphics, robotics, vision, computer animation, etc.
Course Outcomes: At the end of the course student should be able to	
1	Analyze various algorithms with practical applications along with their resource requirements.
2	Explore advanced design and analysis techniques.
3	Explain major graph algorithms and their analyses.
4	Analyze linear programming and string matching algorithms.
5	Identify NP-complete problems and offer solutions to solve such problems.

Sr. No.	Module	Detailed Content	Hours
1	Foundations	Algorithms, Analysing algorithms, Growth of Functions-Asymptotic notation, Mathematical Background for algorithm analysis Recurrences, The substitution method, The recursion-tree method, The master method, Randomized algorithms	3

2	Advanced Design and Analysis Techniques	Dynamic Programming-Elements of dynamic programming, Matrix-chain multiplication Greedy Algorithms-Elements of the greedy strategy, Huffman codes Amortized Analysis-Aggregate analysis, The accounting method, The potential method, Dynamic tables	5
3	Graph Algorithms	Single-Source Shortest Paths-The Bellman-Ford algorithm, Dijkstra's algorithm, Difference constraints and shortest paths All-Pairs Shortest Paths-The Floyd-Warshall algorithm Maximum Flow-Flow networks, The Ford-Fulkerson method, Maximum bipartite matching	7
4	Computational Geometry	Line-segment properties, determining whether any pair of segments intersects, Finding the convex hull, Finding the closest pair of points	6
5	NPC and Approximation Algorithms	NP-Completeness: NP-completeness and reducibility, NP-completeness proofs, NP-complete problems, Approximation algorithms: The vertex-cover problem, The traveling-salesman problem, The set-covering problem, The subset-sum problem	8
6	Applied Algorithms	Number-Theoretic: Number Theoretic notion, Greatest common divisor, The Chinese remainder theorem, RSA String Matching Algorithms: The Rabin-Karp algorithm, The Knuth-Morris-Pratt algorithm, Longest common subsequence Parallel Algorithm: Mesh Algorithm and its applications Probabilistic Algorithm: Game Theoretic Techniques Randomized Algorithms: Monte Corlo and Las Vegas algorithms	10
			39

Text Books:	
1	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", PHI, India Second Edition

2	Horowitz, Sahani and Rajsekaran, Fundamentals of Computer Algorithms", Galgotia
3	Rajeev Motwani, PrabhakarRaghavan, " Randomized Algorithm", Cambridge University Press
Reference Books:	
1	Aho, Hopcroft, Ullman: The Design and analysis of algorithms", Pearson Education
2	Vijay V. Vajirani, "Approximation Algorithms",Springer.
3	S. K. Basu, "Design Methods and Analysis of Algorithm", PHI
4	Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGraw-Hill Edition
Internal Assessment:	
	Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
Theory Examination:	
	1. Question paper will comprise of total six question 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. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ME-CSC102	Advanced Computer Network and Design	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Prerequisite: Computer Network	
Course Objectives:	
1	To study the problem of congestion control and service integration in TCP/IP networks focusing on protocol design, implementation and performance issues.
2	To understand the principles of network design and enable students to setup, configure and interconnect an IP network.
3	To debate the current trends and leading research in the computer networking area.
Course Outcomes: At the end of the course student should be able to	
1	Understand the theoretical issues in protocol design and apply it to Quality of service in networks
2	Understand issues in the design of network processors and apply them to design network systems
3	Simulate working of wired and wireless networks to understand networking concepts.
4	Develop solutions by applying knowledge of mathematics, probability, and statistics to network design problems.
5	Understand the basics of software defined networking and explore research problems in that area.

Module		Content	Hrs
1		**Internetworking**	**8**
	1.1	**Congestion control and Resource allocation**: Issues of Resource Allocation, Queuing Disciplines: FIFO, Fair Queuing, TCP Congestion	

		Control: Additive Increase/Multiplicative Decrease, Slow Start, Fast Retransmit and Fast Recovery.	
	1.2	**Congestion-Avoidance Mechanisms**: DECbit, Random Early Detection (RED), Source-Based Congestion Avoidance, Quality of Service: Application Requirements, Integrated Services (RSVP), Differentiated Services (EF, AF).	
2		**Routing**	**7**
		IPv4 Routing Principles, Routing Information Protocol (RIP), IGRP and EIGRP, OSPF for IPv4 and IPv6, Border Gateway Protocol (BGP), EIGRP, High Availability Routing.	
3		**IPv6**	**5**
		IPv4 deficiencies, patching work done with IPv4, IPv6 addressing, multicast, Anycast, ICMPv6, Neighbour Discovery, Routing, Resource Reservation, IPv6 protocols.	
4		**Network Design**	**10**
	4.1	Designing the network topology and Solutions-Top down Approach: PPDIOO – Network Design Layers - Access Layer, Distribution Layer, Core/Backbone Layer, Access Layer Design, Backbone Network Design.	
	4.2	Enterprise LAN Design: Ethernet Design Rules and Campus Design best practices, Virtualisation and Data Center Design, Wireless LAN Design, WAN Design: Traditional WAN Technologies, VPN Design.	
5		**Ad Hoc Wireless Networks**	**5**
		MAC Protocols for Ad Hoc Wireless Networks: MACA/W, MACA-BI, DPRMA, MACA/PR. Routing Protocols for Ad Hoc Wireless Networks: DSDV, DSR, AODV, ZRP. Transport Layer: ATCP.	
6		**Software Defined Networking and OpenFlow**	**4**
		Introduction to Software Defined Networking, Control and Data Planes, SDN Controllers, Introduction to Openflow Protocol, Network Function Virtualization-Concepts.	
		Total	**39**

Text Books:	
1	Larry L. Peterson and Bruce S. Davie, Computer Networks: A Systems Approach, Elsevier, Fourth Edition.

2	Philip M. Miller, *TCP / IP: The Ultimate Protocol Guide Applications, Access and Data Security - Vol 2, Wiley*
3	Pete Loshin, IPv6: Theory, Protocols and Practice, Morgan Kaufmann, 2nd Edition, 2004
4	Anthony Bruno, Steve Jordan, Official Cert Guide: CCDA, Cisco Press,
5	C. Siva Ram Murthy, B.S. Manoj, Ad Hoc Wireless Networks: Architectures and, Prentice Hall, 2004.
6	Thomas D NAdeau and Ken Grey, Software Defined Networking, O'Reilly, 2013
Reference Books:	
1	William Stallings, High-Speed Networks and Internets, Pearson Education, 2nd Edition, 2002.
2	James F. Kurose, Keith W. Ross, "Computer Networking, A Top-Down Approach Featuring the Internet", Third Edition, Addison Wesley, 2004.
3	Pujolle, Software Networks: Virtualization, SDN, 5G, Security, Wiley,
Internal Assessment:	
	Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
Theory Examination:	
	1. Question paper will comprise of total six question 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. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ME-CSDLO11	Modern Operating System	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Prerequisite: Operating System	
Course Objectives:	
1	To learn the architectural differences and issues related to Operating System.
2	To get a comprehensive knowledge of the distributed systems and Real time operating system.
3	To get a thorough knowledge of database operating systems and cloud operating System.
Course Outcomes: At the end of the course student should be able to	
1	Apply the principles and concepts in analyzing and designing Operating System.
2	Demonstrate the Mutual exclusion, Deadlock detection and agreement protocols of Distributed operating system
3	Analyze the performance and reliability of different Operating Systems.
4	Analyze and solve concurrency control problems in database operating system

Sr. No.	Module	Detailed content	Hours
1	Introduction	Types of Operating Systems. Architectures and design issues of Network operating system, DOS, Middleware, RTS, DBOS. Introduction to process, Concurrent processes, Critical Section problems, other synchronization problems.	4
2	Distributed operating Systems, Scheduling and synchronization	Scheduling: Issues in load distributing, Components of load distributing algorithms, Stability, Load distributing algorithms, Performance Comparison, selecting a suitable load sharing Algorithm.	9

		Synchronization: Physical and logical clocks. Distributed Mutual Exclusion: Introduction, Classification of Mutual Exclusion algorithms, Mutual Exclusion Algorithms. Distributed Deadlock: Introduction, deadlock handling strategies, Deadlock detection: Issues and resolution, Control Organizations, Centralized algorithms, Distributed algorithms, Hierarchical algorithms.	
3	Distributed Fault Handling	Agreement Protocol: System Model, Classification, Solution to Byzantine Agreement Problem. Fault Recovery: Concepts, Classification of failures, Backward error recovery, Recovery in concurrent Systems, Consistent Check Points, Synchronous and Asynchronous check pointing and recovery. Fault tolerance: Issues, Atomic actions and committing, Commit Protocols, Non-blocking Commit protocols, Voting protocols and Dynamic Voting Protocols.	8
4	Real Time Operating Systems	Types of Real time tasks, Timing Constraints, Modeling Timing Constraints. Task Scheduling: Types of tasks and their characteristics, Task Scheduling, Clock driven Scheduling, Hybrid Schedulers, Event driven Scheduling, EDF Scheduling, Rate Monotonic Algorithm Resource Handling: Resource Sharing, Priority Inversion, PIP, PCP, HLP. Scheduling real time tasks in distributed systems	9
5	Database Operating systems	Concurrency control: Database systems, Concurrency control model of database systems, Problem of Concurrency Control, serializability theory, Distributed Database Systems Concurrency Control Algorithms: Basic synchronization Algorithms, Lock based, Timestamp based and Optimistic Algorithms, Concurrency Control Algorithms : Data Replication	04
6	Case Study	DOS: Mach, Amoeba RTOS: UNIX as RTOS, Windows as RTOS. Mobile OS. Cloud OS	04
		Total	39

Text books:

1. Mukesh Singhal, Niranjan G.Shivaratri, "Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems" MC Graw Hill education.
2. Rajib Mall, “Real-Time Systems: Theory and Practice”, Pearson education.

Reference Books:

1. Andrew S.Tanenbaum, "Modern Systems Principles and Paradigms". PHI.
2. Pradeep K.Sinha, "Distributed Operating System-Concepts and design", PHI.
3. Andrew S.Tanenbaum, "Distributed Operating System", Pearson Education.
4. Jane W. S. Liu, “Real Time Systems”, Pearson education.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
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.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ME-CSDLO12	Logic & Automated Reasoning	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Course Objectives:
1. Represent mathematical and other knowledge using logical formalism.
2. Understand theoretical concepts and results that form the basis of current automated reasoning systems.
3. Understand advanced techniques of resolution theorem proving and be able to use them.

Course Outcomes: At the end of the course student should be able to
1. Comprehend syntax and semantics of Propositional logic, first-order logic, inference system, proof, soundness and completeness.
2. Apply various deductive algorithms and models for reasoning
3. Emphasize various techniques for automated reasoning, theorem proving

Sr. No.	Module	Detailed Contents	Hours
1	Introduction to Logic	Mathematical Logic, Propositional Logic, First-Order Logic, Modal Logic, Temporal Logic, Program Verification	04
2	Propositional Logic	Formulas, Models, Tableaux: Propositional Formulas, Interpretations, Logical Equivalence, Sets of Boolean Operators, Satisfiability, Validity and Consequence, Semantic Tableaux, Soundness and Completeness Resolutions: Conjunctive Normal Form, Clausal Form, Resolution Rule, Soundness and Completeness of Resolution Binary Decision Diagrams: Motivation Through Truth Tables, Definition of Binary Decision Diagrams, Reduced Binary Decision Diagrams	10
3	First-Order Logic	Formulas, Models, Tableaux: Relations and Predicates, Formulas in First-Order Logic, Interpretations, Logical Equivalence, Semantic Tableaux, Soundness and Completion of Semantic Tableaux	10

		Resolution: Ground Resolution, Substitution, Unification, General Resolution, Soundness and Completeness of General Resolution Introduction to Logic Programming: Prolog	
4	Reasoning Methods	SAT Solvers: Properties of Clausal Form, Davis-Putnam Algorithm, DPLL Algorithm Deductive Systems: Gentzen System, Hilbert System Terms and Normal Forms : First-Order Logic with Functions, PCNF and Clausal Form, Herbrand Models	07
5	Automated Reasoning	Automated Reasoning for Web system, Semantic Web applications, REWERSE-automated reasoning method and tools,	04
6	Theorem Proving	Some exposure to theorem proving systems such as Prolog, PVS, SPIN	04
		Total	39

Text Books	
1.	Mordechai Ben-Ari, Mathematical Logic for Computer Science, Third Edition, Springer
2	Arindama Singh, Logics for Computer Science, Prentice Hall of India.
Reference Books	
1.	Handbook of Practical Logic and Automated Reasoning, John Harrison, Cambridge University Press
2.	Michael Huth and Mark Ryan, Logic in Computer Science: Modelling and Reasoning about Systems, Cambridge University Press.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
Note: One Case Study to be given for Module 5 and 6 based on the above concepts.

Theory Examination:

1. Question paper will comprise of total six question
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.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ME-CSDLO13	Database Systems: Design and Implementation	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination			Term Work	Pract	Oral	
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Prerequisite: Basic knowledge of Database Management System.

Course Objectives:

1. To introduce principles and foundations of distributed database.
2. To impart knowledge of query processing and optimization.
3. To introduce the concept of document-oriented database.
4. To create awareness about potential security threats to a database and mechanisms to handle it.
5. Understand the usage of advanced data models for real life application.

Course Outcomes: At the end of the course student should be able to

1. Design distributed database for better resource management.
2. Understand and analyse Query processing and optimization techniques.
3. Describe developments in database technology.
4. Apply appropriate security techniques to the database systems.
5. Implement advanced data models for real life applications.

Sr No	Module Content	hours
1. Introduction, Distributed database design	Centralized versus non centralized Databases, Homogeneous and Heterogeneous DDBMS and their comparison, Distributed database design: Concept, Objective of Data Distribution, Data Fragmentation, The allocation of fragment, Concepts of replication servers Transparencies in Distributed Database Design	5
2. Query Processing and Optimization	Query Processing Problem, Objectives of Query Processing, Complexity of Relational Algebra Operations, Layers of Query Processing Query Decomposition and Data Localization: Query	8

	Decomposition, Localization of Distributed Data.	
3. Document oriented database Object Oriented Database:	Need of object-oriented database, Impedance matching problem between OO languages and Relational database, Case study db4O Document Oriented Database: Need of Document Oriented database, difference between Document Oriented Database and Traditional database, Types of encoding XML, JSON, BSON, Representation XML, Json Objects. Case study on doc oriented based such a Mariadb	6
4. Advanced data models	Temporal data models, Aspects of valid time, Bitemporal time and bi-temporal time with examples of each. Spatial model: Types of spatial data models - Raster, Vector and Image	6
5. Data Security Introduction to Database Security Issues;	Authentication and authorization, Database auditing, Discretionary Access Control Based on Granting and Revoking Privileges, Mandatory Access Control and Role-Based Access Control for Multilevel Security Introduction to Statistical Database Security	6
6. Advance Databases	MYSQL Postgres, Mobile databases, NoSQL, Native XML databases (NXD), Document oriented databases, Graph database Federated Databases: Architecture, Development task, System operation	8
	Total	39

Books Recommended:

Text books:

1. Elmasri & Navathe, “Fundamentals of Database Systems” IV edition. PEARSON Education.
2. Korth, Silberschatzsudarshan, “Database systems, concepts” 5th edition McGraw Hill
3. Ruosell J.T. Dyer, Learning MySQL and Mariadb.
4. M. Tamer Ozsu , Patrick Valduriez, “Principles of Distributed Database”, Pearson Education India

Reference Books:

1. Chhanda Ray, “Distributed Database System”, Pearson Education India.
2. Hector Garcia-Molina, Jeffery D. Ullman, Jennifer Widom, “Database system Implementation”
3. Thomas M.Connolly Carolyn Begg, Database Systems: A practical Approach to Design, Implementation and Management, 4/e.

Online References:

Federated Database: https://dev.mysql.com/doc/refman/8.0/en/federated-description.html

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ME-CSDLO14	Computational Intelligence	03	--	--	03	--	--	03

Examination Scheme						
Theory Examination				Term Work	Pract	Oral
Internal Assessment			End Sem Exam			
Test 1	Test 2	Avg				
20	20	20	80	--	--	--

Course Objectives:

1. To explore the various computational Intelligence techniques
2. To become familiarized with Neural Network, Fuzzy logic & evolutionary techniques
3. To learn to apply computational Intelligence to different applications

Course Outcomes: At the end of the course student should be able to

1. Understand the importance of computational Intelligence.
2. Analyze various computational Intelligence technology
3. Design and implement various intelligent system.

Prerequisite: Soft Computing, Mathematics

Sr. No.	Module	Detailed content	Hours
1	Introduction to Computational Intelligence paradigms	Artificial Neural Networks, Fuzzy Systems, Genetic Algorithms, Swarm Intelligence, Artificial Immune System, Applications	5
2	Artificial Neural Networks & SVM	Basic models of ANN: NN Architecture, MP Neuron, Linear separability, activation functions, types of learning Learning Rules: Hebbian, Perceptron, Delta, Winner-take all Supervised NN: Perceptron Network: SDPTA, SCPTA, MCPTA, Adaline networks Support Vector Machine: Binary SVM	10
3	Fuzzy Systems	Fuzzy Sets: Definition, operations, properties, relations, characteristics, membership functions, defuzzification.	7

4	Optimization	GA: Selection, Encoding, Crossover, Mutation, Examples. Swarm Intelligence: Single Solution Particle Swarm Optimization: Guaranteed Convergence PSO, Social-Based Particle Swarm Optimization, Hybrid Algorithms, Sub-Swarm Based PSO, Multi-Start PSO Algorithms, Repelling Methods, Binary PSO, Ant Algorithm: Simple Ant Colony Optimization	8
5	Artificial Immune System	Natural Immune System: Classical view, Antibodies and antigens, Artificial Immune Models: Artificial Immune system algorithm, classical view models, CLONALG	4
6	Applications	Character Recognition, Genetics Algorithm in game playing, Color Recipe prediction- Single MLP approach ANT algorithm/Swarm Intelligence – TSP, Best path finding	5
		Total	39

Text Books:

1. Andries P. Engelbrecht, Computational Intelligence an Introduction, Wiley, 2nd Edition

2. S.N. Sivanandam, S.N. Deepa, Principles of Soft Computing, Wiley, 2nd edition

3. Jacek M. Zurada, Introduction to Artificial Neural Systems, West Publication

4. Theodoridis and Koutroumbas , Pattern Recognition, 4th Edition, Academic Press

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six question
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.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

<table>
<tr><th rowspan="2">Subject Code</th><th rowspan="2">Subject Name</th><th colspan="3">Teaching Scheme
(Contact Hours)</th><th colspan="4">Credits Assigned</th></tr>
<tr><td>Theory</td><td>Pract</td><td>Tut</td><td>Theory</td><td>Pract</td><td>Tut</td><td>Total</td></tr>
<tr><td rowspan="6">ME-CSDLO15</td><td rowspan="6">Component Based System Design</td><td>03</td><td>--</td><td>--</td><td>03</td><td>--</td><td>--</td><td>03</td></tr>
<tr><td colspan="7">Examination Scheme</td></tr>
<tr><td colspan="4">Theory Examination</td><td rowspan="3">Term Work</td><td rowspan="3">Pract</td><td rowspan="3">Oral</td></tr>
<tr><td colspan="3">Internal Assessment</td><td rowspan="2">End Sem Exam</td></tr>
<tr><td>Test 1</td><td>Test 2</td><td>Avg</td></tr>
<tr><td>20</td><td>20</td><td>20</td><td>80</td><td>--</td><td>--</td><td>--</td></tr>
</table>

Prerequisite:	
Course Objectives:	
1	To gain the knowledge of current component models in terms of their design, management and related issues.
2	A detailed study of the concepts and engineering principles of software component and component-based software systems.
3	A clear understanding of use of a robust Integrated Development Environment for software development and how to navigate around this environment using the tools available.
4	Develop skills for programming in an object-oriented environment, using class components and their properties and methods to build new software products.
Course Outcomes: At the end of the course student should be able to	
1	Understanding of component based systems, their purpose and scope.
2	Analyze Software Engineering practices related to Component Based Development.
3	Assess how the component models measure up to the goals of component based development.
4	Gain in depth knowledge of fundamental properties of components, technology and architecture and middleware.
5	Apply design Of Software Component Infrastructures and frameworks.
6	Develop and deploy large-scale component based Web applications.

Module		Content	Hrs
1		**Component Definition**	**06**
	1.1	Definition of Software Component and its Elements.	
	1.2	Component Models and Component Services: Concepts and Principles, COTS Myths and Other Lessons Learned in Component-Based Software Development, Roles for Component-Based Development.	
	1.3	Common High-Risk Mistakes in Component-Based Software Engineering (CBSE), CBSE Success Factors: Integrating Architecture, Process, and Organization.	
2		**Software Engineering Practices**	**04**
	2.1	The Practice of Software Engineering.	
	2.2	From Subroutines to Subsystems: Component-Based Software Development.	
3		**The Design of Software Component Infrastructures**	**07**
	3.1	Software Components and the UML.	
	3.2	Component Infrastructures: Placing Software Components in Context, Business Components.	
	3.3	Components and Connectors: Catalysis Techniques for Defining Component Infrastructures, An Open Process for Component-Based Development, Designing Models of Modularity and Integration.	
4		**The Management of Component-Based Software Systems**	**07**
	4.1	Measurement and Metrics for Software Components, The Practical Reuse of Software Components, Selecting the right COTS Software.	
	4.2	Importance of requirements, Software Component Project Management Processes, The Trouble with Testing Software Components.	
	4.3	Configuration Management and Component Libraries, The Evolution, Maintenance and Management of Component-Based Systems.	
5		**Component Technologies**	**08**
	5.1	Overview of the CORBA Component Model, Transactional COM+.	

	5.2	Designing Scalable Applications, The Enterprise JavaBeans Component Model, Choosing Between COM+, EJB, and CCM.	
	5.3	Software Agents as Next Generation Software Components.	
6		**Component framework and development**	**07**
	6.1	Connectors, contexts, CLR contexts and channels.	
	6.2	Black Box component framework, directory objects, cross development environment.	
	6.3	Component oriented programming, component design and implementation tools, testing tools, assembly tools.	
		Total	**39**

Reference Books:	
1	Addison Wilsey," Component-Based Development: Principles and Planning for Business Systems", 2010.
2	Lau, K.-K. (Kung-Kiu), "An introduction to component-based software development", World Scientific Publishing,2018.
3	Clemens Szyperski, "Component Software: Beyond Object-Oriented Programming", Pearson Education, 2003.
4	Don Box, Dorling Kingsley, Essential COM (2006).

Assessment:	
Internal Assessment:	
Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.	
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.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ME-CSDLO16	ICT for Social Cause	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Sr.No	Course Objectives
1	To appreciate various theoretical and disciplinary perspectives towards deploying ICT system for development of society.
2	To illustrate different ways by which information can be communicated.
3	To demonstrate an understanding for acquiring data securely for developing an ICT system.
4	To illustrate data storage techniques and formulate knowledge from the raw data.
5	To formulate policies and strategies for ICT system.
6	To design various application using ICT.

Sr. No.	**Course Outcomes:** At the end of the course student should be able to
1	To identify opportunities and challenges for developing ICT systems.
2	To identify and access the ways by which information can be communicated.
3	To identify methods of capturing data securely for developing an ICT system.
4	To store and analyze the data captured and generate knowledge from the raw data.
5	To devise policies and strategies for ICT system.
6	To design various application using ICT.

Sr. No.	Module	Detailed Content	Hours
0	Prerequisite	Introduction to ICT	
1	**Introduction and Basics of ICT**	Review of ICT history and growth, importance of ICT in societal development identifying opportunities for using ICT, learning from failures Drivers and barriers for ICT development ICT in developing countries – opportunities for developments and challenges Creating an ICT – handling text, data and media.	4
2	**Communication Techniques in ICT**	Radio and TV Techniques, Mobile Techniques – CDMA, Mobile wireless WiMAX, Advanced wireless technologies, Bluetooth Satellite Techniques – architecture AND working principles GPS/GPRS Cloud computing –Introduction, cloud services, Cloud service providers, collaborative techniques like sharing ideas through blogs, forums, online communities etc safe transmission of data	9
3	**Data acquisition in ICT**	Recognition systems RFID, OMR Location recognition Data acquisition process for MEMS devices Sensors – Programming, communication with cloud. Acquiring data from internet and social media. Formation of social groups and interaction analysis Facebook, Twitter, Blogs, Forums, mailing lists etc controlling access to confidential information	9
4	**Data and Knowledge Management in ICT**	Data storage and management, content management system, identity management Knowledge elicitation, Knowledge representation and visualization techniques Knowledge Engineering Methodology Auditing knowledge management Data storage and disposal of data Linking knowledge management to business performance	8
5	**Defining policies for administering ICT**	ICT policies and e-Strategies, approach to ICT policy formulation and e-Strategy development, e-Readiness assessment, identifying priority areas and developing action plans. National Policy on ICT in India.	5
6	**ICT applications**	Study of ICT applications in various domains such as Agriculture, Healthcare, Education, social studies, Finance, Law, life science.	4
		Total	39

Text Books:

1. Lechman, E. (2015). ICT Diffusion in Developing Countries: Towards a New Concept of Technological Takeoff. Germany: Springer International Publishing.
2. ffordability Issues Surrounding the Use of ICT for Development and Poverty Reduction. (2018). United States: IGI Global.
3. Koh, S. C. L., Maguire, S. (2009). Information and Communication Technologies Management in Turbulent Business Environments. United Kingdom: Information Science Reference.
4. The Development Dimension ICTs for Development: Improving Policy Coherence. (2010). Ukraine: OECD Publishing.
5. Gorica, K., Kordha Tolica, E., Sevrani, K. (2015). Information Society Development Through ICT Market Strategies: Albania Versus Other Developing Countries. Germany: Springer International Publishing.
6. ICT Futures: Delivering Pervasive Real-time And Secure Services Edited By Paul Warren , John Davies, David Brown , Wiley Publication.
7. ICT Policy Formulation and e-Strategy Development Strategy Development - A Comprehensive Guidebook by Richard Labelle, Asia-Pacific Development Information Programme.

Online References:

1. BLI-224: ICT Fundamentals - https://onlinecourses.swayam2.ac.in/nou22_lb08/preview

Assessment:

Internal Assessment Test:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered inquestion papers of end semester examination.

<table>
<tr><th rowspan="2">Subject Code</th><th rowspan="2">Subject Name</th><th colspan="3">Teaching Scheme
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<tr><td>Theory</td><td>Pract</td><td>Tut</td><td>Theory</td><td>Pract</td><td>Tut</td><td>Total</td></tr>
<tr><td rowspan="6">ME-CSDLO17</td><td rowspan="6">Internet for Everything</td><td>03</td><td>--</td><td>--</td><td>03</td><td>--</td><td>--</td><td>03</td></tr>
<tr><td colspan="7">Examination Scheme</td></tr>
<tr><td colspan="4">Theory Examination</td><td rowspan="3">Term Work</td><td rowspan="3">Pract</td><td rowspan="3">Oral</td></tr>
<tr><td colspan="3">Internal Assessment</td><td rowspan="2">End Sem Exam</td></tr>
<tr><td>Test 1</td><td>Test 2</td><td>Avg</td></tr>
<tr><td>20</td><td>20</td><td>20</td><td>80</td><td>--</td><td>--</td><td>--</td></tr>
</table>

Sr. No.	Course Objectives
1	To describe the concepts of Objects in IOT, IOT Identifier, IOT Technologies.
2	To discuss and elaborate RFID architecture, RFID Tag and Reader along with the protocols used to solve the RFID issues faced in RFID applications.
3	To describe the connecting and networking nodes in a secure communication with the help of protocols such as MQTT, CoAP, and REST.
4	To explain Hadoop MapReduce and demonstrate its usage for real time batch data Analysis using Apache Oozie, Apache Spark and Apache Storm.
5	To summarize the use of ML algorithms in IoT Based application in Healthcare and Smart Transportation.
6	To elaborate and show how the analysis and the evaluation is carried out over the data received through sensors in IOE to ensure security in IOE applications.

Sr. No.	**Course Outcomes:** At the end of the course student should be able to
1	Identify the Objects in IOT, list the IOT Identifiers and know the different technologies.
2	Explain RFID architecture, list the Components, identify RFID Tag and Reader along with the protocols used to solve the RFID issues faced in RFID applications.

3	Design applications using the communication protocols such as MQTT, CoAP, and REST.
4	Use Hadoop MapReduce for real time batch data Analysis using Apache Oozie, Apache Spark and Apache Storm.
5	Recall the ML algorithms used in IoT Based applications in Healthcare and Smart Transportation.
6	Analysis and evaluate the data received through sensors in IOE and Security in IOE applications.

Sr. No	**Module**	**Detailed Contents**	**Hours**
0	**Prerequisites**	IOT Lab, Sensor Lab, Wireless Network.	
1.	Introduction to IOE	Introduction and History of IOT, Objects in IOT IOT Identifier, IOT Technologies **Self-Learning Topics:** History of IOT, Compare IOT & IOE	**5**
2.	Radio-frequency identification (RFID) Technology	Introduction to RFID and Principles of RFID RFID Components and RFID Tag and Reader RFID Transponder and RFID architecture RFID Middleware Protocols: Tree protocols, Tree splitting algorithms, Binary search Algorithms RFID Challenges and Applications **Self-Learning Topics:** Binary search Algorithms	**7**
3.	Wireless Sensor Networks	Connecting and networking nodes, Securing communication, standards, IP Addressing Protocols - MQTT, CoAP, REST **Self-Learning Topics**: Industrial WSN Standards	**6**
4.	Hadoop MapReduce	Introduction to Hadoop MapReduce, Architecture of Hadoop and Hadoop Ecosystem Hadoop MapReduce for Batch Data Analysis	**7**

		Apache Oozie, Apache Spark, Apache Storm Real-time Data Analysis Using Apache Storm **Self-Learning Topics:** Apache Hadoop Setup	
5	**IoT with ML**	Machine Learning in IoT Based Healthcare Applications, General Architecture of H-IoT Overview of Algorithms and Security of health data, Machine Learning in IoT Based Smart Transportation, ML algorithms to support Smart Transportation **Self-Learning Topics:** Deep Learning in IOT	**6**
6.	**Security in IoE**	Common Challenges in OT Security. How IT and OT Security Practices and Systems Vary Formal Risk Analysis Structures: OCTAVE and FAIR Convergence of IoE and Blockchain its security challenges **Self-Learning Topics:** Trust based Recommender Systems in IoT	**5**
		Total	**39**

Text Book	
1	Hakima Chaouchi, Internet of Things connecting objects to the web. Wiley.
2	Arshdeep Bhaga and Vijay Madisetti, Internet of Things - A Hands-on-Approach.
3	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry, "IoT Fundamentals – Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1 st Edition, Pearson Education, Cisco Press, 2017
Reference Books	
1	Samuel Greengard, The Internet of Things (MIT Press).
2	Hakima Chaouchi, The Internet of Things - Connecting objects to the web. Wiley Publications.
3	Herve chabanne, RFID and the Internet of Things. Wiley Publications.
Reference Papers	
1	H. K. Bharadwaj et al., "A Review on the Role of Machine Learning in Enabling IoT Based Healthcare Applications," in IEEE Access, vol. 9, pp. 38859-38890, 2021, doi: 10.1109/ACCESS.2021.3059858.
2	Zantalis, F.; Koulouras, G.; Karabetsos, S.; Kandris, D. A Review of Machine Learning and IoT in Smart Transportation. Future Internet 2019, 11, 94. https://doi.org/10.3390/fi11040094

3	L. Wei, J. Wu, C. Long and Y. -B. Lin, "The Convergence of IoE and Blockchain: Security Challenges," in IT Professional, vol. 21, no. 5, pp. 26-32, 1 Sept.-Oct. 2019, doi: 10.1109/MITP.2019.2923602.
	Useful Links
1	https://nptel.ac.in/courses/106/105/106105166/
2	https://nptel.ac.in/courses/108/108/108108098/
3	https://nptel.ac.in/courses/106/105/106105195/
4	https://www.coursera.org/specializations/IoT

Assessment:

Internal Assessment Test:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered inquestion papers of end semester examination.

<table>
<tr><th rowspan="2">Subject Code</th><th rowspan="2">Subject Name</th><th colspan="3">Teaching Scheme (Contact Hours)</th><th colspan="4">Credits Assigned</th></tr>
<tr><td>Theory</td><td>Pract</td><td>Tut</td><td>Theory</td><td>Pract</td><td>Tut</td><td>Total</td></tr>
<tr><td rowspan="6">ME-CSDLO18</td><td rowspan="6">Web Application Security</td><td>03</td><td>--</td><td>--</td><td>03</td><td>--</td><td>--</td><td>03</td></tr>
<tr><td colspan="7">Examination Scheme</td></tr>
<tr><td colspan="4">Theory Examination</td><td rowspan="3">Term Work</td><td rowspan="3">Pract</td><td rowspan="3">Oral</td></tr>
<tr><td colspan="3">Internal Assessment</td><td rowspan="2">End Sem Exam</td></tr>
<tr><td>Test 1</td><td>Test 2</td><td>Avg</td></tr>
<tr><td>20</td><td>20</td><td>20</td><td>80</td><td>--</td><td>--</td><td>--</td></tr>
</table>

Sr.No	Course Objectives:
1	To reveal the underlying in web application.
2	To understand the browser security principles.
3	To understand web applications vulnerabilities.
4	To understand web application mitigations.
5	To identify and aid in fixing any security vulnerabilities during the web development process.
6	To understand the security principles in developing a reliable web application.

Sr. No.	**Course Outcomes:** At the end of the course student should be able to
1	To understand the security principles in developing a reliable web application
2	Identify the various types of security issues in web browser.
3	Identify the various types of threats in developing a web application.
4	Identify the various types of mitigation measures of web applications.
5	Apply the security principles in developing a reliable web application.
6	Use industry standard tools for web application security.

Prerequisite: Introduction to Information & Network Security.

Sr. No.	Module	Detailed Content	Hours
0	Prerequisite	Overview of Web Applications: Introduction history of web applications interface ad structure benefits and drawbacks of web applications Web application Vs Cloud application	2
I	Web Application Security Fundamentals	Security Fundamentals: Input Validation - Attack Surface Reduction Rules of Thumb- Classifying and Prioritizing Threads **Self-learning Topics:** Cookies, Access Control.	**4**
II	Browser Security Principles	Origin Policy - Exceptions to the Same-Origin Policy - Cross-Site Scripting and Cross-Site Request Forgery - Reflected XSS - HTML Injection **Self-learning Topics:** HTTPS, HTTP Proxies.	**4**
III	Web Application Vulnerabilities	Understanding vulnerabilities in traditional client server application and web applications, client state manipulation, cookie based attacks, SQL injection, cross domain attack (XSS/XSRF/XSSI) http header injection. SSL vulnerabilities and testing - Proper encryption use in web application - Session vulnerabilities and testing - Cross-site request forgery **Self-learning Topics:** SSH Tunneling, Cleaning traces ,Cleaning the event log Advanced phishing attacks	**8**
IV	Web Application Mitigations	HTTP request, HTTP response, rendering and events, html image tags, image tag security, issue, java script on error, Java script timing, port scanning , remote scripting , running remote code, frame and iframe , browser sandbox, policy goals, same origin policy, library import, domain relaxation **Self-learning Topics:** Nikto, OWASP ZAP.	**7**
V	Secure Website Design	Secure website design: Architecture and Design Issues for Web Applications, Deployment Considerations Input Validation, Authentication, Authorization, Configuration Management, Sensitive Data, Session Management, Cryptography, Parameter Manipulation, Exception Management, Auditing and Logging, Design Guidelines, Forms and validity, Technical implementation **Self-learning Topics:** Wapiti**,** SQL Map	**7**
VI	Cutting Edge Web Application Security	Clickjacking - DNS rebinding - Flash security - Java applet security - Single-sign-on solution and security - IPv6 impact on web security **Self-learning Topics:** https://owasp.org/www-community/Free_for_Open_Source_Application_Security_Tools	**4**

Text Books:

1. Sullivan, Bryan, and Vincent Liu. Web Application Security, A Beginner's Guide. McGraw Hill Profe ssional, 2011.

2. Stuttard, Dafydd, and Marcus Pinto. The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws. John Wiley Sons, 2011

References:

1. OReilly Web Security Privacy and Commerce 2nd Edition 2011

2. Professional Pen Testing for Web application, Andres andreu, wrox press

3. Carlos Serrao, Vicente Aguilera, Fabio Cerullo, "Web Application Security" Springer; 1st Edition.

Assessment:

Internal Assessment Test:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered inquestion papers of end semester examination.

<table>
<tr><th rowspan="2">Subject Code</th><th rowspan="2">Subject Name</th><th colspan="3">Teaching Scheme (Contact Hours)</th><th colspan="4">Credits Assigned</th></tr>
<tr><td>Theory</td><td>Pract</td><td>Tut</td><td>Theory</td><td>Pract</td><td>Tut</td><td>Total</td></tr>
<tr><td rowspan="6">ME-CSL101</td><td rowspan="6">Computational Laboratory-I</td><td>--</td><td>--</td><td>--</td><td>---</td><td>02</td><td>--</td><td>01</td></tr>
<tr><td colspan="7">Examination Scheme</td></tr>
<tr><td colspan="3">Theory Examination</td><td rowspan="3">End Sem Exam</td><td rowspan="3">Term Work</td><td colspan="2" rowspan="3">Pract / Oral</td></tr>
<tr><td colspan="3">Internal Assessment</td></tr>
<tr><td>Test 1</td><td>Test 2</td><td>Avg</td></tr>
<tr><td>---</td><td>---</td><td>---</td><td>---</td><td>25</td><td colspan="2">25</td></tr>
</table>

Module	Detailed Content	Lab Session
Algorithm and Complexity	• Implementation of algorithms which demonstrate greedy strategy, dynamic programming, Flow network, parallel algorithm and string matching (any two).	05
Networking Design	• Install tool CISCO Packet Tracer Student Edition (open-source). Explore this tool and use it to design an Internetwork using switches, routers and the concept of VLAN. Configure different routing protocols like RIP, OSPF, EIGRP etc. on the network you have designed and observe the performance. Test your network using “ping” and “show ip route”. • Install mininet (open-source). Create virtual architecture for SDN openvswitch(s), host(s), controllers(s) and test various topologies using basic commands like ping. Optionally connect mininet openvswitch with external controllers like open day light (open-source).	05

Course Code	Course Name	Credits
ILO 1011	**Product Life Cycle Management**	**03**

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to…

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Sr. No.	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):** Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital	05

	mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	
05	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
06	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

5. Question paper will comprise of total **six questions**, **each carrying 20 marks**
6. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
7. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
8. Only **Four questions need to be solved**.

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Credits
ILO 1012	Reliability Engineering	03

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Sr. No	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:**Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if 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**.

REFERENCES:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO 1013	Management Information System	03

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Sr. No.	Detailed Contents	Hrs
01	Introduction to Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if 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**.

REFERENCES:

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO 1014	Design of Experiments	03

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Sr. No	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
03	**Two-Level Factorial Designs** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07

05	**Response Surface Methods and Designs** 5.1 Introduction to Response Surface Methodology 5.2 The Method of Steepest Ascent 5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	07
06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if 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**.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

Course Code	Course Name	Credits
ILO 1015	Operations Research	03

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Sr. No.	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05

03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if 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**.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons

Course Code	Course Name	Credits
ILO 1016	Cyber Security and Laws	03

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Sr. No.	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if 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**.

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Course Code	Course Name	Credits
ILO 1017	Disaster Management and Mitigation Measures	03

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Sr. No.	Detailed Contents	Hrs
01	***Introduction*** 1.1 ***Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.***	03
02	***Natural Disaster and Manmade disasters:*** ***2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion*** 2.2 ***Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.***	09
03	***Disaster Management, Policy and Administration*** ***3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.*** ***3.2 Policy and administration:*** ***Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.***	06
04	***Institutional Framework for Disaster Management in India:*** ***4.1 Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster***	06

	management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. ***4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.***	
05	***Financing Relief Measures:*** ***5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams.*** ***5.2 International relief aid agencies and their role in extreme events.***	09
06	Preventive and Mitigation Measures: 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if 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**.

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications

7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO 1018	Energy Audit and Management	03

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Sr. No	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system.	10

	General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if 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.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Credits
ILO1019	**Development Engineering**	**03**

Objectives:

1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development.
2. To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
3. An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals
4. To understand the Nature and Type of Human Values relevant to Planning Institutions

Outcomes: Learner will be able to…

1. Apply knowledge for Rural Development.
2. Apply knowledge for Management Issues.
3. Apply knowledge for Initiatives and Strategies
4. Develop acumen for higher education and research.
5. Master the art of working in group of different nature.
6. Develop confidence to take up rural project activities independently

Sr. No.	**Module Contents**	**Hrs**
01	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	**08**
02	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development	**04**
03	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	**06**

04	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	**04**
05	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	**10**
06	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	**04**

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately
40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if 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

References:

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission

5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory andPractice, Vol. 4, No.4, pp.395 – 407

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ME-CSC201	Cloud Computing and Services	03	--	--	03	--	--	03
		Examination Scheme						
		Theory Examination				Term Work	Pract	Oral
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		20	20	20	80	--	--	--

Sr.No	Course Objectives:
1	To learn the perspective of cloud computing and virtualization
2	To understand the idea behind mobile cloud computing
3	To determine the meaning of mobile offloading
4	To assess the concept of green cloud computing
5	To explore the resource allocation techniques and various business models
6	To analyze various cloud and mobile computing environments for real world application

Sr. No.	Course Outcomes: At the end of the course student should be able to
1	Understand the concepts behind cloud computing and virtualization.
2	Apply the knowledge of mobile cloud computing to various applications
3	Determine the various techniques of loading in cloud computing applications.
4	Design applications to make the systems energy efficient.
5	Select the required cloud computing resources and develop a business model.
6	Apply various techniques to develop various high ended mobile cloud computing applications

Sr. No.	Module	Detailed Content	Hours
0	Prerequisite	Cloud Computing models, Virtualization, Primary and Secondary services offered by the cloud.	
I	Introduction to Cloud Computing and virtualization	Virtualization: Need for virtualization, Features and types of virtualization, Hypervisors and its types. Cloud Computing**:** Introduction to Cloud Computing, Layers and Types of Clouds, Features of Cloud computing system, Cloud Infrastructure Management, Infrastructure as a Service, Platform as a Service, software as a service, Challenges and Risks, Secondary services. **Self-learning Topics:** Case study on Service model Dockers, OSGi (Application level virtualization library)	06
II	Mobile cloud computing	Mobile cloud computing: Need for Mobile cloud computing system, Definition, Architecture, Challenges, Characteristics and Benefits of Mobile cloud computing. Mobile cloud computing service framework Mobile cloud solutions, Mobile cloud service models, Mobile Cloud computation, Mobile Cloud storage, Mobile Cloud security and privacy, Mobile Cloud Computing context awareness, Mobile as a service consumer, Mobile as a service provider, Mobile as service broker. **Self-learning Topics:** Mobile cloud computing platforms and software.	06
III	Offloading in Mobile Cloud Computing	Definition of offloading, composition, migration Introduction to offloading , Offloading Decision, Types of Offloading, Topologies of Offloading, Offloading in Cloud Computing and in Mobile Cloud Computing: Similarities and Differences, Adaptive Computation Offloading from Mobile Devices, Cloud Path Selection for Offloading, Mobile Data Offloading Using Opportunistic Communication, Three-Tier Architecture of Mobile Cloud Computing, Requirements of Data Offloading, Performance Analysis of Offloading Techniques Multi-Cloud Offloading in Mobile Cloud	06

		computing environment, Mobile cloud computing offloading models **Self-learning Topics:** Mobile cloud offloading framework: clonecloud, Thinkair, MAUI, Cuckoo, weblet	
IV	Green Mobile Cloud Computing	Introduction**,** Requirements and issues, Devices used, Computational offloading, Resource management, Service provisioning, Green location sensing, Energy saving. **Self-learning Topics:** Measures taken by IT industries towards green computing and challenges in adopting green computing.	06
V	Resource allocation and business model for mobile cloud computing	Resource allocation in mobile cloud computing: Simple, dynamic and adaptive resource allocation models. Challenges and issues in resource allocation, Techniques in mobile cloud computing. Mobile cloud computing business models: Advantages, issues and applications. Business Models for social mobile cloud **Self-learning Topics:** Business model requirements, cloud computing business model	06
VI	Applications of Mobile cloud computing	Mobile cloud media computing applications: Location identification, Human Tracking, Mobile learning applications, Cloud streaming applications, Vehicle monitoring and Biometric applications. Tips for creating cloud mobile applications, Context aware mobile computing system, **Self-learning Topics:** Cross cloud communication applications, Elastic application models	06

Text Books:

1. Rajkumar Buyya , James Broberg,Andrzej M. Goscinski, Cloud Computing: Principles and Paradigms
2. Kailesh Jayaswal, Jagannath Kallakurchi, Donald J Houde, Cloud computing
3. Dijiang Huang and Huijun Wu, Mobile cloud computing: foundation and service model
4. Debashis De, Mobile computing architecture, algorithm and application

References:

1. Barrie Sosinsky, Cloud computing Bible
2. Dr Kumar Saurabh, Cloud computing

Lab Work:

1. Demonstrate how to build ML/AL capabilities on cloud for mobile applications
2) Explain how mobile offline data synchronization can be done using any cloud platform

Assessment:

Internal Assessment Test:

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination:

Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered inquestion papers of end semester examination.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ME-CSC202	Exploratory Data Analytics and Visualization	03	--	--	03	--	--	03

Examination Scheme						
Theory Examination				Term Work	Pract	Oral
Internal Assessment			End Sem Exam			
Test 1	Test 2	Avg				
20	20	20	80	--	--	--

Prerequisite: Engineering Mathematics, Data Structures, Algorithms	
Course Objectives:	
1	To understand the foundations of the Data Science process, methods and techniques
2	To represent and organize knowledge about large heterogeneous data collections
3	To use mathematical models and tools for large-scale data analysis and reasoning
4	To work and evaluate Data at Scale
Course Outcomes: At the end of the course student should be able to	
1	Appreciate the science of statistics and the scope of its potential applications
2	Summarize and present data in meaningful ways
3	Select the appropriate statistical analysis depending on the research question at hand
4	Understand and verify the underlying assumptions of a particular analysis
5	Effectively and clearly communicate results from analyses performed to others

Module		Content	Hrs
1		**Introduction to Data Science**	09

	1.1	Data science process: Defining goal, retrieving data, preprocessing data, exploratory data analysis, model building and data visualization, Ethical issues in data science.	
	1.2	Probability: review of probability theory, normal distribution, sampling	
	1.3	Simple Linear Regression, F-test and t-test for Simple Linear Regression, Residual Plots, Outliers and Influence Points, Multiple linear regression, F-test and t-tests for Multiple Linear Regression.	
2		**Predictive and Descriptive Models**	**09**
	2.1	Descriptive Modeling: Principal components analysis (PCA), singular value decomposition (SVD), probabilistic PCA, applying PCA to new data, PCA for data interpretation., EM algorithm for PCA, Independent Component Analysis (ICA), Maximum likelihood estimation using EM.	
	2.2	Predictive Modeling: Predictive modeling process, supervised and unsupervised learning, parametric and nonparametric models, business intelligence, challenges in using predictive analytics	
	2.3	Introduction to time series analysis and time series mining, Introduction to spatio-temporal data, spatio-temporal model, fast dynamic time warping.	
3		**Evaluation and Methodology of Data Science**	**03**
	3.1	Experimental setups, training, tuning, test data, holdout method, cross-validation, bootstrap method	
	3.2	Measuring performance of a model: Accuracy, ROC curves, precision-recall curves, loss functions for regression	
	3.3	Interpretation of results: Confidence interval for accuracy, hypothesis tests for comparing models, algorithms	
4		**Data Communication and Information Visualization**	**06**
	4.1	Data Communication: cost Function, how to Minimize cost function, coefficients of determination.	
	4.2	Information visualization: effective information visualization, visual Encodings, perception of visual cues, data scales, visualizing time series data, data journalism, dashboards	
5		**Analysis of Variance (ANOVA)**	**06**

	5.1	One-Way Analysis of Variance, F-test for ANOVA, Evaluating Group Differences, Type I and Type II Errors	
	5.2	Issues with Multiple Comparisons, Assumptions of Analysis of Variance, Relationship between One-Way Analysis of Variance and Regression, One-Way Analysis of Covariance, Two-Way Analysis of Variance and Covariance	
6		**Analysis for proportions**	**06**
	6.1	One-Sample Tests for Proportions, Significance Tests for a Proportion, Confidence Intervals for a Proportion	
		Two-Sample Tests for Proportions, Confidence Intervals for Differences in Proportions, Significance Tests for Differences in Proportions, Effect Measures, Logistic Regression, Multiple Logistic Regression, Area under the ROC Curve	
		Total	**39**

Reference Books:

1	Davy Cielen, Meysman,Mohamed Ali, “Introducing Data Science”, Dreamtech Press
2	Kevin P. Murphy, “Machine Learning a Probabilistic Perspective”, The MIT Press
3	Dean Abbott, “Applied Predictive Analytics: Principles and Techniques for the Professional Data Analyst”, Wiley, 2014
4	Noel Cressie, Christopher K. Wikle , “Statistics for Spatio-Temporal Data, Wiley
5	Seema Acharya and Subhashini Chellappan, “Big Data and Analytics”, Wiley
6	Rachel Schutt and Cathy O’Neil, “Doing Data Science”, O’Reilly Media
7	Joel Grus, Data Science from Scratch: First Principles with Python, O'Reilly Media
8	Teetor, P. (2011). R cookbook. Sebastopol, CA: O'Reilly. ISBN 9780596809157
9	Chang, W. (2013). R graphics cookbook. Sebastopol, CA: O'Reilly. ISBN 9781449316952
10	Andy Field, Jeremy Miles and Zoe Field. (2012) Discovering Statistics Using R. Publisher: SAGE Publications Ltd. ISBN-13: 978-1446200469
11	Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani. (2013) An Introduction to Statistical Learning with Applications in R. Springer

Assessment:	
Internal Assessment:	
Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.	
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	Data sets for Machine Learning algorithms: https://www.kaggle.com/datasets
2	https://towardsdatascience.com/machine-learning/home
3	https://onlinecourses.nptel.ac.in/noc21_cs85/preview
4	https://www.openintro.org/stat/