AC 14/7/2016
Item No. 4.25

UNIVERSITY OF MUMBAI

Revised Syllabus

For

Master of Engineering

Program: M. E. (Computer Engineering)

Under

FACULTY OF TECHNOLOGY

(As per Choice Based Credit and Grading System)

from

Academic Year 2016-17

From Co-ordinator's Desk:

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 Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's) and course objectives and course outcomes 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. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

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 not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Choice Based Credit and Grading System were implemented for First Year Master of Engineering from the academic year 2016-2017. Subsequently this system will be carried forward for Second Year Master of Engineering in the academic year 2017-2018.

Dr. Suresh K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Preamble:

The M. E. in Computer Engineering programme is offered to students who are interested in advanced learning and research in any area of Computer Science and Engineering. Applicants to this programme are expected to have a background in Computer Science and Engineering or Information Technology.

The objective of the programme is to enable the learner to apply his/her enhanced skill and knowledge at the top research laboratories and companies in the country and even abroad.

The programme is a 72-credit degree programme, which is usually spread over 4 semesters for a full-time student. About two-thirds of the credits involve coursework, and the remaining consists of project work. The emphasis is on conducting original research and writing a thesis individually. The programme is flexible enough to allow a student to specialize in any topic of interest by taking elective (optional) courses and working on a research project in that area.

University of Mumbai feels that it is desirable to provide specialized ME programme in Computer Engineering to address the needs of the industry, which today requires more specialized resource in each field.

Faculty of Technology, University of Mumbai has taken a lead in incorporating philosophy of Choice Based Education in the process of curriculum development.

Dr. Subhash K. Shinde

Chairperson,

Adhoc Board of Studies in Computer Engineering,

University of Mumbai, Mumbai.

Program Structure for ME Computer Engineering,

(With Effect from 2016-2017)

University of Mumbai)

Semester –I

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSC101	Algorithm & Complexity	04	---	---	04	---	---	04
CSC102	Advance Computer Network and Design	04	---	---	04	---	---	04
CSC103	Advanced Operating Systems	04	---	---	04	---	---	04
CSDLO-I	Department Level Optional Course-I	04	---	---	04	---	---	04
ILO-I	Institute Level Optional Course-I	03	---	---	03	---	---	03
CSL101	Computational Laboratory-I	--	02	--	01	---	--	01
CSL102	DEC Laboratory-I	--	02	--	01	---	--	01
Total		19	04	--	21	--	--	21

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
CSC101	Algorithm & Complexity	20	20	20	80	3	--	---	100
CSC102	Advance Computer Network and Design	20	20	20	80	3	--	---	100
CSC103	Advanced Operating Systems	20	20	20	80	3	--	---	100
CSDLO-I	Department Level Optional Course-I	20	20	20	80	3	--	---	100
ILO-I	Institute Level Optional Course-I	20	20	20	80	3	--	---	100
CSL101	Computational Laboratory-I	---	---	---	----	----	25	25	50
CSL102	DEC Laboratory-I	---	---	---	----	----	25	25	50
Total		100	100	100	400	----	50	50	600

Program Structure for ME Computer Engineering,

(With Effect from 2016-2017)

University of Mumbai)

Semester –I

Course Code	Department Level Optional Course-I	Course Code	Institute Level Optional Course-I
CSDLO1011	Logic & Automated Reasoning	ILO1011	Product Lifecycle Management
CSDLO1012	Image Analysis & Interpretation	ILO1012	Reliability Engineering
CSDLO1013	Natural Language Processing	ILO1013	Management Information System
CSDLO1014	Computational Intelligence	ILO1014	Design of Experiments
CSDLO1015	User Experience Design	ILO1015	Operation Research
		ILO1016	Cyber Security and Laws
		ILO1017	Disaster Management & Mitigation Measures
		ILO1018	Energy Audit and Management

Program Structure for ME Computer Engineering,

(With Effect from 2016-2017)

University of Mumbai

Semester –II

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CS201	High performance Computing	04	---	---	04	---	---	04
CS202	Data Science	04	---	---	04	---	---	04
CS203	Ethical Hacking and Digital Forensics	04	---	---	04	---	---	04
CSDLO-II	Department Level Optional Course –II	04	---	---	04	---	---	04
ILO-II	Institute Level Optional Course-II	03	---	---	03	---	---	03
CSL201	Computational Laboratory-II	--	02	--	01	---	--	01
CSL202	DEC Laboratory-II	--	02	--	01	---	--	01
Total		19	04	---	21	--	--	21

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
CSC201	High performance Computing	20	20	20	80	3	--	---	100
CSC202	Data Science	20	20	20	80	3	--	---	100
CSC203	Ethical Hacking and Digital Forensics	20	20	20	80	3	--	---	100
CSDLO-II	Department Level Optional Course –II	20	20	20	80	3	--	---	100
ILO-II	Institute Level Optional Course-II	20	20	20	80	3	--	---	100
CSL201	Computational Laboratory-II	---	---	---	---	----	25	25	50
CSL202	DEC Laboratory-II	---	---	---	---	----	25	25	50
		100	100	100	400	----	50	50	600

Program Structure for ME Computer Engineering,

(With Effect from 2016-2017)

University of Mumbai

Semester –II

Course Code	Department Level Optional Course -II	Course Code	Institute Level Optional Course-II
CSDLO2021	Data Storage & Retrieval	ILO2021	Project Management
CSDLO2022	Internet of Things	ILO2022	Finance Management
CSDLO2023	Advance Soft Computing	ILO2023	Entrepreneurship Development and Management
CSDLO2024	Semantic Web & Social Network Analysis	ILO2024	Human Resource Management
CSDLO2025	ICT for Social cause	ILO2025	Professional Ethics and CSR
		ILO 2026	Research Methodology
		ILO2027	IPR and Patenting
		ILO2028	Digital Business Management
		ILO2029	Environmental Management

Program Structure for ME Computer Engineering,

(With Effect from 2016-2017)

University of Mumbai

Semester –III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CS301	Special Topic Seminar	----	06	--	---	03	--	03
CS302	Dissertation-I	---	24	--	---	12	--	12
Total		**----**	**30**	**--**	**---**	**15**	**--**	**15**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
CS301	Special Topic Seminar	---	---	---	---	---	50	50	100
CS302	Dissertation-I	---	---	---	---	---	100	---	100
Total		**---**	**---**	**---**	**----**	**---**	**150**	**50**	**200**

Semester –IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CS401	Dissertation-II	--	30	--	---	15	--	15
Total		**--**	**30**	**--**	**---**	**15**	**--**	**15**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duratio n (in			
		Test 1	Test 2	Avg.					
CS401	Dissertation-II	--	---	---	---	---	100	100	200
Total		**--**	**---**	**---**	**---**	**---**	**100**	**100**	**200**

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
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	--	--	--

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 prove the correctness and analyze the running time of the basic algorithms for those classic problems in various domains
- Able to apply the algorithms and design techniques to solve problems.

Prerequisite: Data structure, Analysis of Algorithms, Set Theory

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	4
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	6

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	8
4	Computational Geometry	• Line-segment properties, Determining whether any pair of segments intersects, • Finding the convex hull, Finding the closest pair of points	8
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	10
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	12

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. SanjoyDasgupta, Christos Papadimitriou, UmeshVazirani, “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 carry 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
CSC102	Advanced Computer Networking 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	--	--	--

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: Learner will able to

- Understand the theoretical issues in protocol design and apply it to Quality of service in networks.
- Understand issues in the design of network processors and apply them to design network systems
- Simulate working of wired and wireless networks to understand networking concepts.
- Develop solutions by applying knowledge of mathematics, probability, and statistics to network design problems.
- Understand the basics of software defined networking and explore research problems in that area.

Sr. No.	Module	Detailed content	Hours
1	**Internetworking**	**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. **Congestion-Avoidance Mechanisms**: DECbit, Random Early Detection (RED), Source-Based Congestion Avoidance, Quality of Service: Application Requirements, Integrated Services (RSVP), Differentiated Services (EF, AF).	10

2	**Routing:**	IPv4 Routing Principles, Routing Information Protocol (RIP), IGRP and EIGRP, OSPF for IPv4 and IPv6, Border Gateway Protocol (BGP), EIGRP, High Availability Routing.	08
3	**IPv6**	IPv4 deficiencies, patching work done with IPv4, IPv6 addressing, multicast, Anycast, ICMPv6, Neighbour Discovery, Routing, Resource Reservation, IPv6 protocols.	06
4	**Network Design:**	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, 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.	14
5	**Ad Hoc Wireless Networks**	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.	06
6	**Software Defined Networking and OpenFlow**	Introduction to Software Defined Networking, Control and Data Planes, SDN Controllers, Introduction to Openflow Protocol, Network Function Virtualization-Concepts.	04

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: Virtualisation, 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 carry 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
CSC103	Advanced 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	--	--	--

Course Objectives:

1. To learn the architectural differences and issues related to Advanced 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: Learner will able to

- Apply the principles and concepts in analyzing and designing Advance Operating System.
- Demonstrate the Mutual exclusion, Deadlock detection and agreement protocols of Distributed operating system
- Analyze the performance and reliability of different Advanced Operating Systems.

Sr. No.	Module	Detailed content	Hours
1	Introduction	• Types of Advanced 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.	04
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. • 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	12

		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.	10
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	12
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	06
6	Case Study	• DOS: Mach, Amoeba • .RTOS : UNIX as RTOS , Windows as RTOS. • Mobile OS. • Cloud OS	04

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.

The suggested lists of experiment/case study of Advanced Operating System are as follows:

I. Flexibility/Load Distribution

1) Implement and study the incremental/decremented growth of response and service times for different number of client and servers for servicing continuous stream(s) of constant sized messages.
2) Implement a name server for registration and identification of services running on another server. The client contacts the name server for a particular service and the service request is forwarded to the specific server registered on the name server. Study the load distribution for different number of service servers, clients and service requests.

II. Fault Tolerance/Reliability

1) Implement a fault tolerant client and server application using the concept of name server. The client incorporates fault tolerant by sending a service request to another server using name server, if the current server fails to respond within 10 seconds.
2) Implement a stateful server for a transaction consisting of mainly four operations viz. open a file, close opened file, read from opened file and write to opened file. The state of file operation is maintained at stateful server.

III. Performance

1) Implement a client-server application for a computing problem (of exponential complexity). Compare the performance for a local and remote machine of different speeds.
2) Implement parallel Fast-Fourier-Transform (parallel FFT). Show that the overall communication time complexity is O ((n/p) log p), and the computational complexity of the parallel algorithm is O (n log n/p) where n is number of elements, and p is number of processes.

IV. Transparency

1) Implement a client-server application to show transparent service access so that the client does not know the location of service is being executed.

V. Mobile Application

1) Implement a client-server application to allow transfer of any data (e.g. images, documents, videos etc.) on android mobile operating system. Each mobile device runs a program which acts as a server when it receives data from another device or a client when it sends data to another mobile device.
2) Implement a distributed share list among a group of mobile device users which is similar to Google document.

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 carry 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
CSDLO1011	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.

Outcomes: Learner will be able to ...

- Comprehend syntax and semantics of Propositional logic, first-order logic, inference system, proof, soundness and completeness.
- Apply various deductive algorithms and models for reasoning
- 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	12
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 • Resolution: Ground Resolution, Substitution, Unification, General Resolution, Soundness and	12

		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	08
5	Automated Reasoning	• Automated Reasoning for Web system, • Semantic Web applications, • REWERSE-automated reasoning method and tools,	06
6	Theorem Proving	• Some exposure to theorem proving systems such as Prolog, PVS, SPIN	06

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.

<u>Theory Examination:</u>

1. Question paper will comprise of total six question
2. All question carry 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
CSDLO1012	Image Analysis and Interpretation	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	--	--	--

Objective:

1. To explore the various Image Analysis and Interpretation techniques
2. To become accustomed with different methods of Feature generation, Representation Description and Interpretation.
3. To Analyze & Interpret Images and use for various applications

Outcome: Learner will able to

- Understand the importance of Image Analysis and Interpretation.
- Analyze various methods of Image Analysis
- Use the methods of image analysis and interpretation for various Image Processing applications.

Prerequisite: Image Processing, Mathematics**.**

Sr. No.	Module	Detailed content	Hours
1	Introduction to Image Processing System	• Introduction, • Sources of Images • Classification of Images • Elements of Image Processing System • Image Modelling – Sampling, Quantization and Representing Digital Images. • Image Preprocessing – ○ Enhancement : Power Law Transformation, Contrast Stretching and Histogram Equalization ○ Spatial domain Filters: Smoothing, Sharpening	08

2	Feature Generation	• Introduction • Basis Vectors and Images • K-L transformation • Singular Value Decomposition • Independent Component Analysis • Non–Negative Matrix Factorization • Non- linear Dimension Reduction • Haar Transform • Multi resolution Interpretation	12

3	Image Analysis	• Data Structure for Image Analysis
		  ○ Levels of image data representation
		  ○ Traditional image data structures
		  ○ Hierarchical data structures
		• Image Segmentation
		  ○ Thresholding
		  ○ Edge based and Region Based Segmentation
		  ○ Boundary Extraction
		• Feature Extraction
		  ○ Spatial Feature Extraction
		  ○ Transform Feature Extraction
			10

4	Image Representation and Description	• Boundary Representation • Region Representation • Moments Representation • Structure Representation • Shape Representation • Texture Representation	06 .
5	Statistical decision making and Vector Quantization	• Statistical decision making: Bayesian theorem Multiple features Conditionally independent features Decision boundaries Unequal cost of error Estimation of error rates • Vector Quantization	08
6	Applications	Case Study on • Remote Sensing Images • Medical Images • Image Forensics: Finger print classification • Digital Watermarking for Images	04

Text Books:

1. Fundamentals of Digital Image Processing Anil K. Jain, PHI
2. Pattern Recognition, Theodoridis & Koutroumbas, 4th Edition, Academic Press
3. Digital Image Processing ,Second Edition, Rafael C. Gonzalez and Richard E.Woods, Pearson Prentice Hall,
4. Digital Image Processing, S Jayaraman, S Esakkirajan, T Veerakumar,Tata McGraw-Hill Education Private Limited, 2011.
5. Digital Image Processing, S. Sridhar, Oxford University Press.
6. Image Processing, Analysis, and Machine Vision, Milan Sonka Vaclav Hlavac Roger Boyle.
7. Pattern recognition and Image analysis by Earl Gose, Richard Johnsonbaugh, Steve Jost, PHI publication

Reference Books:

1. Digital Image Processing An Algorithm Approach, Madhuri A. Joshi, PHI
2. Principles of Soft Computing , S N Shivanandan, S N Deepa, 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.

<u>Theory Examination:</u>

1. Question paper will comprise of total six question
2. All question carry 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
CSDLO1013	Natural Language Processing	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 formulate the problems and solutions of NLP and establish their relation to linguistics and statistics.
2. To implement various language Models.
3. To design systems that uses NLP techniques
4. To train and evaluate empirical NLP systems.

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

- Model linguistic phenomena with formal grammars.
- Design, implement, and analyze NLP algorithms
- Apply NLP techniques to design real world NLP applications, such as machine translation, text categorization, text summarization, information extraction...etc.
- Implement proper experimental methodology for training and evaluating empirical NLP systems.

Prerequisite: Data structure & Algorithms, Theory of computer science, Probability Theory

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1	**Introduction**	History of NLP, Generic NLP system, levels of NLP , Knowledge in language processing , Ambiguity in Natural language , stages in NLP, challenges of NLP ,Applications of NLP- Machine translation, question answering system, Information retrieval, Text categorization , text summarization & Sentiment Analysis	3
2	**Word Level Analysis**	Morphology analysis –survey of English Morphology, Inflectional morphology & Derivational morphology; Regular expression, finite automata, finite state transducers (FST) ,Morphological parsing with FST , Lexicon free FST - Porter stemmer. N –Grams- N-gram language model , N-gram for spelling correction .	9

3	**Syntax analysis**	Part-Of-Speech tagging(POS)- Tag set for English (Penn Treebank) , Rule based POS tagging, Stochastic POS tagging, Issues –Multiple tags & words, Unknown words, class based n –grams .Context Free Grammar – Constituency , Context free rules & trees, Sentence level construction , Noun Phrase, coordination, agreement, the verb phrase & sub categorization	10
4	**Semantic Analysis**	Attachment for fragment of English- sentences, noun phrases, Verb phrases, prepositional phrases, Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy, Wordnet, Selectional restriction based disambiguation & limitations , Robust WSD – machine learning approach and dictionary based approach	10
5	**Pragmatics**	Discourse –reference resolution, reference phenomenon , syntactic & semantic constraints on co reference, preferences in pronoun interpretation , algorithm for pronoun resolution .Text coherence, discourse structure	8
6	**Applications (preferably for Indian regional languages)**	Machine translation, Information retrieval, Question answers system, categorization, summarization, sentiment analysis.	8

Text Books:

1. Daniel Jurafsky, James H. Martin "Speech and Language Processing" Second Edition, Prentice Hall, 2008.
2. Christopher D.Manning and Hinrich Schutze, " Foundations of Statistical Natural Language Processing ", MIT Press, 1999.

Reference Books :

1. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press (2008).
2. Daniel M Bikel and Imed Zitouni " Multilingual natural language processing applications" Pearson, 2013
3. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor) " The Handbook of Computational Linguistics and Natural Language Processing " ISBN: 978-1-118-

Case study/Experiments:

The objective of Natural Language Processing lab is to introduce the students with the basics of NLP which will empower them for developing advanced NLP tools and solving practical problems in this field.

Reference for Experiments: **http://cse24-iiith.virtual-labs.ac.in/#**

Sample Case study/Experiments:

Note: Although it is not mandatory, the experiments can be conducted with reference to any Indian regional language.

1. Word Analysis
2. Word generation
3. Stop word removal
4. Stemming
5. Morphology
6. POS Tagging
7. Chunking
8. N-gram language model

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 carry 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
CSDLO1014	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: Learner will able to

- Understand the importance of computational Intelligence.
- Analyze various computational Intelligence technology
- 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	6
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	14
3	Fuzzy Systems	Fuzzy Sets: Definition, operations, properties, relations, characteristics, membership functions, defuzzification.	8
4	Optimization	GA: Selection, Encoding, Crossover, Mutation, Examples.	10

		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	
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	6

Text Books:

1. Computational Intelligence An Introduction, Andries P. Engelbrecht, Wiley, 2nd Edition
2. Principles of Soft Computing, S.N. Sivanandam, S.N. Deepa, Wiley, 2nd edition
3. Introduction to Artificial Neural Systems, Jacek M. Zurada, West Publication
4. Pattern Recognition, Theodoridis and Koutroumbas , 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 carry 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
CSDLO1015	User Experience 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	--	--	--

Course Objectives:

1. To study and understand importance of user experience design principles
2. To understand elements of user experience design
3. To encourage students to participate in designing futuristic applications

Course Outcomes: Learner will be able to:

- To Apply principles of user experience
- To apply emerging and established technologies to enhance User Experience design
- To create interface for international standards with ethics
- To evaluate user experience.

Pre-requisites: Web Technologies; Software Engineering; Experience in designing interfaces for applications and web sites. Basic knowledge of designing tools and languages like HTML, Java, etc. User experience design is concerned with all the elements that together make up user interface, including layout, visual design, text, brand, sound, and interaction. User Experience Design works to coordinate these elements to allow for the best possible interaction by users.

Sr. No.	Module	Detailed Contents	Hours
1	Introduction	Introduction to interface design, Understanding and conceptualizing Interface, Understandinguser's conceptual cognition.	04
2	Elements of UX Design	Core Elements of User Experience, Working of UX elements	04
3	The UX Design Process – Understanding Users	Defining the UX, Design Process and Methodology, Understanding user requirements and goals, Understanding the Business Requirements/Goals, User research, mental models, wireframes, prototyping, usability testing.	08
4	The UX Design Process- The Structure: Information Architecture and Interaction Design	Visual Design Principles ,Information Design and Data Visualization Interaction Design ,Information Architecture , Wire framing & Storyboarding,UI Elements and Widgets, Screen Design and Layouts	08

5	UX Design Process: Prototype and Test	Testing your Design, Usability Testing,Types of Usability Testing ,Usability Testing Process, Preparing and planning for the Usability Tests, Prototype your Design to Test, Introduction of prototyping tools,conducting Usability Test, communicating Usability Test Results	08
6	UX Design Process: Iterate/ Improve and Deliver	Understanding the Usability Test,findings, Applying the Usability Test, feedback in improving the design. Communication with implementation team. UX Deliverables to be given to implementation team	04

Text Books

1. Interaction Design, Beyond Human Computer Interaction, Rogers, Sharp, Preece Wiley India Pvt Ltd.
2. The essentials of Interaction Design, Alan Cooper, Robert Reimann, David Cronin
3. Designing The user Interface by Shneiderman, Plaisant,Cohen,Jacobs Pearson

Reference Books:

1. The Elements of User Experience by Jesse James Garrett
2. Don't make me think, by Steve Krug
3. Observing the User Experience: A Practitioner's Guide to User Research by Mike Kuniavsky

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 carry 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.

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

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:**Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**ProductDesign:**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,	05

	financial justification of PDM, barriers to PDM implementation	
04	**Virtual Product Development Tools:**For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	**Integration of Environmental Aspects in Product Design:**Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for 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 consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper.Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

5. Question paper will comprise of total six question
6. All question carry equal marks
7. 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)
8. Only Four question 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, AntoninoRisitano, “Product Design for the environment-A life cycle approach”, Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, ImmonenAnselmie, “Product Life Cycle Management”, Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, “Product Lifecycle Management: Driving the next generation of lean thinking”, Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	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

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Assessment:

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

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry 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.

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

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Imporance 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 consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry 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.

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…

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

Module	Detailed Contents	Hrs
01	**Introduction:** Strategy of Experimentation, Typical Applications of Experimental Design, Guidelines for Designing Experiments, Response Surface Methodology.	06
02	**Fitting Regression Models:** Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression, Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit.	08
03	**Two-Level Factorial Designs:** The 2^2Design, The 2^3 Design, The General 2^k Design, A Single Replicate of the 2^kDesign, The Addition of Center Points to the 2^kDesign, Blocking in the 2^kFactorial Design, Split-Plot Designs.	07
04	**Two-Level Fractional Factorial Designs:** The One-Half Fraction of the 2^k Design, The One-Quarter Fraction of the 2^k Design, The General 2^{k-p} Fractional Factorial Design, Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.	07
05	**Conducting Tests:** Testing Logistics, Statistical aspects of conducting tests, Characteristics of good and bad data sets, Example experiments, Attribute Vs Variable data sets.	07
06	**Taguchi Approach:** Crossed Array Designs and Signal-to-Noise Ratios, Analysis Methods, Robust design examples.	04

Assessment:

Internal: 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 in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry 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.

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
6. Philip J Ross, “Taguchi Technique for Quality Engineering,” McGraw Hill.
7. Madhav S Phadake, “Quality Engineering using Robust Design,” Prentice Hall.

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

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05

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

Assessment:

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

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry 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.

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

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime andinformation 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 ofMobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed byMobile Devices, Registry Settings for Mobile Devices, AuthenticationService Security, Attacks on Mobile/Cell Phones, Mobile Devices:Security Implications for Organizations, Organizational Measures forHandling Mobile, Devices-Related Security Issues, OrganizationalSecurity Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

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

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination.

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

1. Question paper will comprise of total six question
2. All question carry 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.

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.

Module	Detailed Contents	Hrs
01	Introduction 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion **2.2** Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	Disaster Management, Policy and Administration 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 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 programme.Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	Financing Relief Measures: 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	09
06	Preventive and Mitigation Measures: 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal:

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

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry 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.

REFERENCES:

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

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

Course Code	Course Name	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

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction	10

	motors, motor retrofitting, soft starters, variable speed drives.	
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

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

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry 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.

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 ; www.bee-india.nic.in

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSL101	Computational Laboratory-I	--	--	--	---	02	--	01

Examination Scheme						
Theory Examination				Term Work	Pract / Oral	
Internal Assessment			End Sem Exam			
Test 1	Test 2	Avg				
---	---	---	---	25	25	

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).	02
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
Advanced Operating System	• The Advanced Operating System laboratory work should clarify the basic concepts of **Flexibility / Load Distribution** (system scales easily to accommodate increase in number of machines with corresponding increase in performance), **performance** (running an application should not be appreciably worse than running it on a single CPU system), **reliability** (system should be available and functional in presence of failures) and **transparency** (system should provide a single system image). • Every student should perform at least two experiments from above categories (i.e. Flexibility/Load Distribution, Fault Tolerance/Reliability, Performance, Transparency and Mobile Application) using C / C++ programming language.	05

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners appointed by the University of Mumbai.

<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="5">CSL102</td><td rowspan="5">DEC 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>

Design and implementation of any case study/ applications based on departmental electives using modern tools.

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners appointed by the University of Mumbai.

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSC201	High Performance Computing	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 learn concepts of parallel processing as it pertains to high-performance computing.
2. To design, develop and analyze parallel programs on high performance computing resources using parallel programming paradigms

Course Outcomes: Learner will be able to:

- Understand different parallel processing approaches and platforms involved in achieving High Performance Computing.
- Understand design Issues and limitations in Parallel Computing.
- Learn to programming using message passing paradigm using open source APIs, design algorithms suited for Multicore processor and GPU systems using OpenCL, OpenMP.
- Analyze and optimize performance parameters.
- Understand HPC enabled Advanced Technologies.

Sr.No	Module	Detailed Content	Hours
1	Parallel Processing approaches	**Introduction to Parallel Processing:** Levels of Parallelism (instruction, transaction, task, thread, memory, and function), Models (SIMD, MIMD, SIMT, SPMD, Data Flow Models, Demand-driven Computation etc.). Loosely coupled and Tightly coupled **HPC Platforms:** Message-passing interface (MPI), Shared-memory thread-based OpenMP programs, hybrid (MPI/OpenMP) programs, Grid Computing, Cloud Computing , Multi-Core Processors, accelerators, GPGPUs	06
2	Design Issues and limitations in Parallel Computing	Parallel Architecture, (Interconnection network, processor Array, Multiprocessor) Designing Parallel algorithms (Partitioning, Communication, Mapping, Matrix input/output)	10

		Issues: Synchronization, Scheduling, Job Allocation, Job Partitioning, Dependency Analysis, Mapping Parallel Algorithms onto Parallel Architectures **Limitations:** Bandwidth Limitations, Latency Limitations, Latency Hiding/Tolerating Techniques and their limitations	
3	Programming using message passing paradigm	Principles, building blocks, MPI, Overlapping communication and computation, collective communication operations, Composite synchronization constructs, OpenMP Threading Building blocks; An Overview of Memory Allocators, Parallel programming model, combining MPI and OpenMP, Shared memory programing	10
4	Parallel Programming using GPGPU	An Overview of GPGPUs, An Overview of GPGPU Programming, An Overview of GPGPU Memory Hierarchy Features, Heterogeneous Computing using OpenCL, An Overview of OpenCL API, Heterogeneous Programming in OpenCL	12
5	Performance Measures	Performance measures: Speedup, efficiency and scalability. Abstract performance metrics (work, critical paths), Amdahl`s Law, Gustavson's law, weak vs. strong scaling, performance bottlenecks, data races and determinism, data race avoidance (immutability, futures, accumulators, dataflow), deadlock avoidance, abstract vs. real performance (granularity, scalability)	06
6	HPC enabled Advanced Technologies	Nanotechnology and its impact on high performance computing, Power aware processing techniques in high performance computing. Case studies on high performance computing	04

Text Books:

1. AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar , "Introduction to Parallel Computing", Pearson Education, Second Edition, 2007.
2. Kai Hwang,Naresh Jotwani, "Advanced Computer Architecture: Parallelism, Scalability, Programmability", McGraw Hill,Second Edition, 2010.

3. Edward Kandrot and Jason Sanders, “CUDA by Example – An Introduction to General Purpose GPU Programming”,Addison-Wesley Professional ©, 2010.
4. Benedict R Gaster, Lee Howes, David R KaeliPerhaad Mistry Dana Schaa, “Heterogeneous Computing with OpenCL”, Elsevier, Second Edition, 2013.

Reference Books:

1. Georg Hager, Gerhard Wellein, “Introduction to High Performance Computing for Scientists and Engineers", Chapman & Hall / CRC Computational Science series, 2011.
2. Michael J. Quinn, “Parallel Programming in C with MPI and OpenMP”, McGraw-Hill International Editions, Computer Science Series, 2008.
3. Kai Hwang, Zhiwei Xu,“Scalable Parallel Computing: Technology, Architecture, Programming”, McGraw Hill, 1998.
4. Laurence T. Yang, MinyiGuo, “High- Performance Computing: Paradigm and Infrastructure” Wiley, 2006.

List of Experiments to be included in Computational Lab II

Solve given problems using OpenMP/MPI/OpenCL and compare their performance on CPU and GPGPU.

1. Matrix-Matrix multiplication – simple/Cannon’s/ DNS algorithm
2. Sorting – Bitonic/Shell sort/Quicksort/Bucket/ Radix
3. All-pairs shortest paths – Dijkstra’s algorithm/Floyd’s algorithm

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 carry 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
CSC202	Data Science	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 understand the foundations of the Data Science process, methods and techniques
2. To represent and organise 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 – Working with Big Data

Course Outcome: Learner will able

- Learn the fundamentals of data science to enable, reproduce and scalable data from a variety of sources.
- Apply statistical methods, regression techniques, and machine learning algorithms to make sense out of data sets both large and small.
- Design, implement, and evaluate the core algorithms underlying an end-to-end data science workflow, analysis, and visualization of information derived from large datasets.
- Apply “best practices" in data science with modern tools

Sr. No.	Module	Detailed Content	Hours
1	Introduction to Data Science	Data science process: Defining goal, retrieving data, preprocessing data, exploratory data analysis, model building and data visualization, Ethical issues in data science. Probability: review of probability theory, normal distribution, Gaussian discriminant analysis: Linear discriminant analysis (LDA), Logistic regression: Bayesian logistic regression,	08
2	Predictive and Descriptive Models	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. Predictive Modeling: Predictive modeling process,	12

		supervised and unsupervised learning, parametric and non-parametric models, business intelligence, challenges in using predictive analytics 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	Experimental setups, training, tuning, test data, holdout method, cross-validation, bootstrap method Measuring performance of a model: Accuracy, ROC curves, precision-recall curves, loss functions for regression Interpretation of results: Confidence interval for accuracy, hypothesis tests for comparing models, algorithms.	03
4	Text Analytics and Recommendation system (RS)	Introducing text mining, text mining techniques, Understanding Text Mining Process, Sentiment Analysis. Introduction to RS, content based RS, collaborative RS, hybrid RS. Issues and challenges RS, examples of real word RS, e.g., Amazon, mobile RS, etc.	08
5	Data Communication and Information Visualization	Data Communication: cost Function, how to Minimize cost function, coefficients of determination. Information visualization: effective information visualization, visual Encodings, perception of visual cues, data scales, visualizing time series data, data journalism, dashboards.	08
6	Scaling with Big Data	Introduction of big data, characteristics of big data, data in the warehouse and data in Hadoop, Importance of Big data, Big data Use cases: patterns for Big data deployment, MapReduce and Hadoop Ecosystem architecture, NoSQL,analyzing data with Pig and R.Sharding, indexing large-scale data, sampling, data leakage, data incest.	09

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. Paul C. Zikopoulos, Chris Eaton, Dirk deRoos, Thomas Deutsch and George Lapis, “Understanding Big Data: Analytics for Enterprise Class Hadoop and streaming Data”, The McGraw Hill Companies, 2012

4. Dean Abbott, “Applied Predictive Analytics: Principles and Techniques for the Professional Data Analyst”, Wiley, 2014
5. Noel Cressie, Christopher K. Wikle , “Statistics for Spatio-Temporal Data, Wiley
6. Seema Acharya and SubhashiniChellappan, “Big Data and Analytics”, Wiley
7. Rachel Schutt and Cathy O’Neil, “Doing Data Science”, O’Reilly Media
8. Joel Grus, Data Science from Scratch: First Principles with Python, O'Reilly Media
9. EMC Education Services,”Data Science and Big Data Analytics”,Wiley
10. DT Editorial Services, “Big Data Black Book”, Dreamtech 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 carry 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
CSC203	Ethical Hacking and Digital Forensics	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 understand underlying principles and many of the techniques associated with the digital forensic practices.
2. To explore practical knowledge about ethical hacking Methodology.
3. To develop an excellent understanding of current cyber security issues and ways that user, administrator and programmer errors can lead to exploitable in securities.

Course Outcomes: Learner will able to

- Understand the concept of ethical hacking and its associated applications in Information Communication Technology (ICT) world.
- Acquire knowledge of various digital forensic tools and ethical hacking.
- Interpret security issues in ICT world, and apply digital forensic tools for security and investigations.
- Achieve adequate perspectives of digital forensic investigation in various applications /devices like Windows/Unix system, mobile, email etc.
- Generate legal evidences and supporting investigation reports.

Sr. No.	Module	Detailed content	Hours
1	Ethical Hacking Methodology	Introduction, Steps of Ethical Hacking: Planning, Reconnaissance, Scanning, Exploitation, post exploitation and result reporting. Ethical Hacking Tool: Metasploit	6Hrs
2	Introduction to Digital Forensics	The Need for Digital Forensics, Types of Digital Forensics, Introduction to Incident Response Methodology, Incident handling steps, Ethics in Digital Forensics.	6 Hrs
3	Data Collection	Live Data Collection from Windows and Unix Systems, Tools for Forensic Duplication, Collecting Network-based Evidence, Evidence Handling - Chain of Custody. Data Collection Forensic Tools : Forensics Toolkit/ WinHex	14 Hrs
4	Data Analysis	Data Analysis, Investigating Windows, Unix Systems, Analysing Network Traffic, Investigating Routers, Email forensics	12 Hrs

		Data Analysis Tools : Nmap/Wireshark/Helix3pro	
5	Mobile Device Forensics	Crime and mobile phones, evidences, forensic procedures, files present in SIM cards, device data, external memory dump, and evidences in memory card, operator's networks.	6 Hrs
6	Forensic Investigation Reporting	Investigative Report Template, Layout of an Investigative Report, Guidelines for Writing a Report	4 Hrs

Text Books:

1. Kevin Mandia, Chris Prosise, "Incident Response and computer forensics", Tata McGraw Hill, 2006.
2. Patrick Engebretson, "The Basics of Hacking and Penetration Testing, Second Edition: Ethical Hacking and Penetration Testing Made Easy", 2nd Edition, Syngress.
3. Investigation Procedures and Response**,** EC-Council Press.

Reference Books:

1. Peter Stephenson, "Investigating Computer Crime: A Handbook for Corporate Investigations", Sept 1999.
2. Debra Littlejohn Shinder and Ed Tittel, "Scene of the Cybercrime: Computer Forensics Handbook", Syngress Publishing, Inc.
3. Eoghan Casey, "Handbook Computer Crime Investigation's Forensic Tools andTechnology", Academic Press, 1st Edition, 2001
4. Nina Godbole, "Information Systems Security", Wiley India, New Delhi
5. William Stallings, "Cryptography and Network Security", Pearson Publication

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 carry 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
CSDLO2021	Data Storage and Retrieval	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. Understand need of storage network with its architecture, features, components, topology, benefits and limitations.
2. Study the impact of downtime in terms of losses and business continuity.
3. Understand the basic terminologies and components in information retrieval systems.
4. Compare and contrast Information Retrieval models.

Course Outcomes: Learner will able to…

- Evaluate storage architecture, ISS, SAN, NAS and IP SAN.
- Design the storage infrastructure for business continuity.
- Implement and evaluate various Information Retrieval Models.

Sr. No.	Modules	Detailed content	Hours
1	Introduction to Data Storage	Need for storage network, Evolution of storage technology and architecture, Key Challenges in managing information, Information lifecycle, Disk drive performance, Fundamental laws governing disk performance.	04
2	Storage System Environment	Basic Software for Storage Networking: Software for SANs, Shared access data managers, Volumes(RAID): Resilience, performance and flexibility, File systems and application performance. Intelligent Storage System:Storage Virtualization: Form of Virtualization, storage virtualization configurations and challenges, Types of storage virtualization. Content-Addressed Storage: Architecture, Object storage and Retrieval in CAS.	08
3	Storage Networking	Storage Area Networks: Fibre Channel, Components of SAN, FC Connectivity, Fibre Channel Ports, Fibre Channel	12

	Technologies	Architecture, Zoning, Fibre Channel Login Types, FC Topologies. Network-Attached Storage: General-Purpose Servers vs. NAS Devices, Benefits of NAS, NAS File I/O, Components of NAS, NAS Implementations, NAS File-Sharing Protocols, NAS I/O Operations, Factors Affecting NAS Performance and Availability. IP SAN: iSCSI, FCIP.	
4	Business Continuity and Enterprise backup	Introduction to Business Continuity: Information availability, BC planning lifecycle, Failure Analysis, Business impact analysis. Enterprise backup software for SAN: Backup management, Enterprise data protection, Backup architecture, Backup policies, Minimizing impact of backup, Lan-free and serverless backup.	06
5	Information Retrieval	Introduction to Information Retrieval(IR), Objectives and Components of IR system, Taxonomy of IR models, Information Retrieval process, Documents and Query forms	06
6	Retrieval Models	Query structure, The matching process, Text analysis	10

Text Books:

1. G. Somasundaram, Alok Shrivastava, "Information Storage and Management", EMC Education services", Wiley Publication, Edition 2009
2. Richard Barker, Paul Massiglia, "Storage Area Network Essentials: A Complete Guide to Understanding and Implementing SANs", Wiley India
3. Robert R. Korfhage, "Information Storage and Retrieval", Wiley Publication

Reference Books:

1. Ulf Troppens,Wolfgang Muller-Friedt,Rainer Wolafka, "Storage Networks Explained" Wiley Publication
2. Spalding, Robert. Storage Networks: The Complete Reference. Tata McGraw-Hill Education, 2003

3. Manning, Christopher D., Prabhakar Raghavan, and Hinrich Schütze. Introduction to information retrieval. Vol. 1, no. 1. Cambridge: Cambridge university press, 2008.

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 carry 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
CSDLO2022	Internet of Things	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. Provide an overview of concepts, main trends and challenges of Internet of Things.
2. Develop the ability to use Internet of Things related software and hardware technologies.
3. Provide the knowledge of data management business processes and analytics of IoT.
4. Develop skills to relate the IoT technologies for practical IoT applications such as smart objects.

Course Outcomes: Learner will able to -

- Explain and interpret the Internet of Things concepts and challenges.
- Experiment with the software and hardware IoT Technologies.
- Understand data management and business processes and analytics of IoT
- Design and develop small IoT applications to create smart objects

Sr. No.	Module	Detailed Content	Hours
1	Introduction to Internet of Things	IoT Paradigm, IoT Architecture – State of the Art, IoT Protocols, IoT Communication Models, IoT in Global Context, Cloud Computing, Big Data Analytics, Concepts of Web of Things, Concept of Cloud of Things with emphasis on Mobile Cloud Computing, Smart Objects.	8
2	Open – Source Prototyping Platforms for IoT	Basic Arduino Programming Extended Arduino Libraries, Arduino – Based Internet Communication, Raspberry PI, Sensors and Interfacing.	8
3	IoT Technology	RFID + NFC, Wireless Networks + WSN, RTLS + GPS, Agents + Multi – Agent Systems, Composition Models for the Web of Things and resources on the Web, Discovery, Search, IoT Mashups and Others.	8

4	Wireless Sensor Networks	History and Context, The Node, Connecting Nodes, Networking Nodes, Secured Communication for IoT.	4
5	Data Management, Business Process and Analytics	Data Management, Business Process in IoT, IoT Analytics, Creative Thinking Techniques, Modification, Combination Scenarios, Decentralized and Interoperable Approaches, Object – Information Distribution Architecture, Object Naming Service (ONS), Service Oriented Architecture, Network of Information, Etc.	12
6	Application and Use Cases	Concrete Applications and Use – Cases of Web Enabled Things: Energy Management and Smart Homes, Ambient Assisted Living, Intelligent Transport, Etc. M2M, Industrial IoT Applications.	8

Text Books:

1. The Internet of Things (MIT Press) by Samuel Greengard.
2. The Internet of Things (Connecting objects to the web) by Hakima Chaouchi ,Wiley .
3. Internet of Things (A Hands-on-Approach) by Arshdeep Bhaga and Vijay Madisetti.

Reference Books:

1. The Internet of Things Key applications and Protocols, 2nd Edition, (Wiley Publication) by Olivier Hersent, David Boswarthick and Omar Elloumi.
2. IoT –From Research and Innovation to Market development, River Publication by Ovidiu Vermesan and Peter Friess.
3. Building Internet of Things with Arduino by Charalampos Doukas.

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 carry 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
CSDLO2023	Advanced Soft Computing	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	--	--	--

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Course Objectives:

1. To familiarize various soft computing techniques.
2. To relate various soft computing techniques in practical scenario.
3. To understand hybrid approach for application development.

Course Outcomes: At the end of the course, the learner will be able to-

- To demonstrate various soft computing techniques.
- To apply and analyze different soft computing techniques for solving practical applications.
- To design an intelligent system for social and technical problems.

Pre-requisite: Basic mathematics, soft computing, Computational intelligence

Sr. No.	Module	Detailed content	Hours
1	Introduction	Differentiate Hard and Soft Computing, Soft Computing Constituents, Neuro Fuzzy and Soft Computing Characteristics	2
2	Fuzzy Logic & Rough Set Theory	Fuzzy Relations and Fuzzy Rules, Generalized Modens Ponens, Defuzzification and its Types Fuzzy Inference Systems, Design of Fuzzy Controller, Introduction to Rough Sets	12
3	Supervised Network	Error Back Propagation Training Algorithm, Radial Basis Function	10
4	Unsupervised Network	Kohenon Self Organizing Maps, Basic Learning Vector Quantization, Basic Adaptive Resonance Theory	12

5	Hybrid Systems and Introduction to Deep Learning	Fuzzy-Neural Systems, Neuro-Genetic Systems Fuzzy-Genetic Systems, Deep Learning : Definition & background, historical context of deep learning, Three classes of deep learning network.	8
6	Applications and Case Study	Automobile Fuel Efficiency using ANFIS Color Receipe prediction using CANFIS	4

Text Books

1. J.S.R.Jang "Neuro-Fuzzy and Soft Computing" PHI 2003.
2. S. Rajasekaran and G.A. Vijaylakshmi Pai.. Neural Networks Fuzzy Logic, and Genetic Algorithms, Prentice Hall of India.
3. Satish Kumar "Neural Networks A Classroom Approach" Tata McGrawHill.
4. S.N.Sivanandam, S.N.Deepa "Principles of Soft Computing" Second Edition, Wiley Publication.
5. Samir Roy, Udit Chakraborty "Introduction to Soft Computing" Pearson Education India.
6. Jacek.M.Zurada "Introduction to Artificial Neural Sytems" Jaico Publishing House.
7. Timothy J.Ross "Fuzzy Logic With Engineering Applications" Wiley.

Reference Books:

1. Fakhreddine O. Karry, Clarence De Silva," Soft Computing and Intelligent systems Design Theory, Tools and Applications" Pearson 2009.
2. Li Deng and Dong Yu , ‘Deep Learning Methods and Applications’.

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:

5. Question paper will comprise of total six question
6. All question carry equal marks
7. 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)
8. 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
CSDLO2024	Semantic Web & Social Network Analysis	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	--	--	--

Semantic Web provide a graph model (RDF), a query language (SPARQL) and schema definition frameworks(RDFS and OWL) to represent and exchange knowledge online. These technologies provide a whole new way of capturing social networks in much richer structures. Social network Analysis(SNA) tries to understand and exploit the key features of social networks in order to manage their life cycle and predict their evolution. Objective of the course is to understand how to facilitate and enhance the analysis of online social networks, exploiting the power of semantic web technologies.

Course Objectives (CEO):

1. To understand the basics of Semantic Web Technologies
2. To Learn knowledge representation for Semantic Web
3. To understand the importance of Social Network Analysis
4. To understand and use semantic web technologies for social network analysis

Course Outcomes: At the end of the course, the students will be able to :

- Understand the Semantic Web and Social Networks
- Understand Electronic sources for network analysis and different ontology languages.
- Model and aggregate social network data.
- Design and Analyze social network using semantic web technologies.

Pre-requisites: Web Technologies; Data Structures, Databases, Logic-First order logic, knowledge representation, Data Mining ,Distributed Systems.

Sr. No.	Module	Detailed Contents	Hours
1	Introduction Semantic Web and Social Networks: .	The Semantic Web- Limitations of the current Web, The semantic Web Technologies ,A Layered Approach, The emergence of the social web. Social Network Analysis- What is network analysis, Development of Social Network Analysis, Key concepts and measures in network analysis	**04**
2	Semantics and Knowledge Representation on the Semantic Web	Electronic sources for network analysis- Electronic discussion networks, Blogs and online communities Structured Web Documents-XML, Describing web Resources-RDF, RDFSchema, Querying Knowledge Representation on the Semantic Web-SPARQL	**10**

3	Modeling and aggregating social network data:	Ontologies and their role in the Semantic Web, Ontology languages for the Semantic Web-RDFS, OWL. State-of-the-art in network data representation, Ontology Engineering, Semantic Web Knowledge Management Architecture ,Ontological representation of social individuals, Ontological representation of social relationships, Aggregating and reasoning with social network data.	**10**
4	Developing social-semantic applications:	Building Semantic Web applications with social network features, Flink: the social networks of the Semantic Web community, open academia: distributed, semantic-based publication management	**08**
5	Extracting and Mining Communities in social network and social network analysis-	Extracting evolution of Web Community from series of web archive – Detecting communities in social networks- Definition of community – Evaluating communities – methods for community detection and mining – Semantic based social network analysis.	**08**
6	Applications of community mining algorithms , Visualization-	Applications of community mining algorithms-Influence and Homophily, Recommendation, Behavior Analytics, Visualization- Graph theory – Centrality – Clustering- Node Edge Diagrams –Matrix Representation –,Benefits of semantic social networks for communities	**08**

Text Books:

1. Grigoris Antoniou and Frank van Harmelen "Semantic Web Primer"second edition
2. Peter Mika, "Social Networks and the Semantic Web", First Edition, Springer 2007.
3. Reza Zafarani,Mohammad Ali Abbasi,Huan Liu "Social Media Mining: Introduction",Cambridge University press.

Reference Books:

1. Guandong Xu ,Yanchun Zhang and Lin Li, "Web Mining and Social Networking Techniques and applications", First Edition Springer, 2011.
2. Dion Goh and Schubert Foo, "Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively", IGI Global Snippet, 2008.
3. Max Chevalier, Christine Julien and Chantal Soulé-Dupuy, "Collaborative and Social Retrieval and Access: Techniques for Improved user Modelling",IGI Global Snippet, 2009.
4. John G. Breslin, Alexander Passant and Stefan Decker, "The Social Semantic Web", Springer, 2009.
5. Charu C. Aggarwal, "Social Network Data Analytics", Springer; 2011.

6. Borko Furht, “Handbook of Social Network Technologies and Applications”, 1st Edition, Springer, 2010.
7. Toby Segaran,colin Evans and Jamie Taylor “Programming Semantic Web”, O’Reilly.
8. Berners Lee, Godel and Turing “Thinking on the Web “,Wiley inter science, 2008.
9. Vladimir Geroimenko, Chaomei Chen “Visualizing the Semantic Web”, Springer 2006.

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 carry 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
CSDLO2025	Information and Communication Technologies (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	--	--	--

Course Objectives:

1. To understand use of ICT techniques in various applications.
2. To Recognize, Represent and Design the ICT systems for social cause.

Outcome: Learner will able

- To understand technologies used in ICT.
- To design and implement ICT application for societal benefits
- To demonstrate use of emerging technology for social applications.

Sr. No.	Module	Detailed content	Hours
1	Basics of ICT	▪ Introduction to ICT ▪ Challenges and opportunities in using technology for a social cause. ▪ Understanding the social and cultural influences that affect users. ▪ Creating an ICT – handling text, data and media	4
2	Communication Techniques in ICT	▪ 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, ▪ GIS– Working principle and architecture for ICT	12
3	Data acquisition in ICT	• Recognition systems RFID,OMR • Data acquisition process for MEMS devices • Sensors – Programming, communication with cloud. • Formation of social groups and interaction analysis Facebook, Twitter, Blogs, Forums, mailing lists etc	8
4	Data Management in ICT	▪ Data management ▪ Data storage structures	8

5	knowledge management in ICT	▪ Knowledge elicitation ▪ Knowledge Engineering Methodology ▪ Knowledge representation and visualization techniquesAutomatic discovery programs ▪ Data visualization ▪ Auditing knowledge management ▪ Linking knowledge management to business performance	8
6	ICT applications and Social Audit	• Study of ICT applications in various domains such as Agriculture, Healthcare, Education, SCM, Finance, Law. • Social Audit: The Social Audit Tool (SAT), Social Auditing, Characteristics of the SAT, Uses of the SAT , Benefits of the SAT, The SAT Methodology , Purposes, Method, and Approach of the SAT, Implementing the SAT, The Social Auditor	10

References Books:

1. ICT Futures :Delivering Pervasive Realtime And Secure Services Edited By Paul Warren, Jhon Davies, David Brown , Wiley Publication
2. Jochen Schiller, "Mobile communications", Addison wisely, Pearson Education.
3. GIS Fundamentals, Applications and Implementation, Dr.K.Elangovan, New India Publications.
4. Cloud Computing : A practical Approach: By Anthony T. Velte : Tata McGraw-Hill
5. An Introduction to Microelectromechanical systems Engineering, NadimMaluf , Artech House.
6. Knowledge management business intelligence , and content management : The IT practitioner’s Guide by Jessica Keyes
7. ICTs for transfer of technology tools and techniques , S.R. Verma , New India
8. USAID, Social Audit Tool Handbook, Using the Social Audit to Assess the Social Performance of Microfinance Institutions,2008.

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 carry 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.

Course Code	Course Name	Credits
ILO 2021	**Project Management**	**03**

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to…

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects.	8

	Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	
06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Assessment:

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

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry 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.

REFERENCES:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Ed.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Course Code	Course Name	Credits
ILO 2022	**Finance Management**	**03**

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to…

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs;	10

	Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Assessment:

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

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry 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.

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO2023	**Enterpreneurship Development and Management**	**03**

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to…

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Assessment:

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

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry 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.

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO2024	**Human Resource Management**	**03**

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Outcomes: Learner will be able to…

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
02	**Organizational Behavior (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	7

03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	6
04	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	5
05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
06	**HR & MIS** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

Assessment:

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

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry 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.

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO2025	**Professional Ethics and Corporat Social Responsibility (CSR)**	**03**

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to…

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment:

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

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry 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.

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO2026	**Research Methodology**	**03**

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to…

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research:Systematic, Valid, Verifiable, Empirical and Critical	**09**
02	**Types of Research** **2.1**. Basic Research **2.2**. Applied Research **2.3.** Descriptive Research **2.4.** Analytical Research **2.5**. Empirical Research **2.6** Qualitative and Quantitative Approaches	**07**
03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis	**08**

	i. Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached **6.2** Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	**04**

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry 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.

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd ed), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO2027	**IPR and Patenting**	**03**

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to…

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks,Copyrights, Industrial Designs, Plant variety protection, Geographical indications,Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:**Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:**Challenges for IP in digital economy, e-commerce, human genome,biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:**Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publicationetc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry 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.

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** IPR: Drafting,Interpretation of Patent Specifications and Claims**,** New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Credits
ILO 2028	**Digital Business Management**	**03**

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to …..

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business-** Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition	04

	(Process of Digital Transformation)	
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry 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.

References:

1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Credits
ILO2029	**Environmental Management**	**03**

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to…

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Assessment:

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

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry 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.

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management,**T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
CSL201	Computational Laboratory II	--	--	--	---	02	--	01
		Examination Scheme						
		Theory Examination				Term Work	Pract / Oral	
		Internal Assessment			End Sem Exam			
		Test 1	Test 2	Avg				
		---	---	---	---	25	25	

Module	Detailed Content	Lab Session
High Performance Computing	Implement any two parallel algorithms(e.g. sorting, matrix- matrix multiplication) using OpenMP/MPI/OpenCL and compare their performance on CPU and GPGPU.	04
Data Science	Exploratory data analysis using Map Reduce , NoSQL, R, python and Hadoop Ecosystem Predictive data Analytics using open source tools like Rstudio, RWeka, RHadoop	04
Ethical Hacking and Digital Forensics	Operating System Forensics, Email Forensics and Mobile Forensics using open source forensics tools (e.g., Helix3pro, WinHex)	04

Assessment:

Laboratory Project: Weightage for Laboratory Project should be 40% in Final Assessment of Laboratory Work.

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners appointed by the University of Mumbai.

<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">CSL202</td><td rowspan="6">DEC Laboratory-II</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>

Design and implementation of any case study/ applications based on departmental electives using modern tools.

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners appointed by the University of Mumbai.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ME-CS301	Special Topic Seminar	----	06	--	---	03	--	03
ME-CS302	Dissertation-I	---	24	--	---	12	--	12
Total		----	**30**	--	---	**15**	--	**15**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ME-CS301	Special Topic Seminar	---	---	---	---	---	50	50	100
ME-CS302	Dissertation-I	---	---	---	----	---	100	---	100
Total		---	---	---	----	---	**150**	**50**	**200**

Guidelines Special Topic Seminar:

- Seminar should be based on thrust areas in Computer Engineering/ Information Technology.
- Students should do literature survey, identify the topic of seminar and finalize it with consultation of Guide/Supervisor.
- Students should use multiple literatures (at least 10 papers from Refereed Journals/conferences) and understand the topic and research gap.
- Implementation of one paper from refereed journal as a case study.
- Compile the report in standard format and present infront of Panel of Examiners. (Pair of Internal and External examiners appointed by the University of Mumbai).
- It is advisable to students should publish at least one paper based on the work in reputed International / National Conference.

Note: At least 4-5 hours of course on Research Methodology should be conducted which includes literature survey, identification of problems, analysis and interpretation of results and technical paper writing in the beginning of 3rd semester.

Guidelines for Dissertation-I

Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation-I

Dissertation-I should be assessed based on following points

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization
- Clarity of objective and scope

Dissertation-I should be assessed through a presentation by a panel of Internal examiners and external examiner appointed by the Head of the Department/Institute of respective Programme.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut	Total
ME-CS401	Dissertation-II	--	30	--	---	15	--	15
Total		--	30	--	---	15	--	13

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in			
		Test 1	Test 2	Avg.					
ME-CS401	Dissertation-II	--	---	---	---	---	100	100	200
Total		--	---	---	---	---	100	100	200

Guidelines for Assessment of Dissertation II

Dissertation II should be assessed based on following points:

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization or current Research / Industrial trends
- Clarity of objective and scope
- Quality of work attempted or learner contribution
- Validation of results
- Quality of Written and Oral Presentation

Students should publish at least one paper based on the work in referred National/ International conference/Journal of repute.

Dissertation II should be assessed by internal and External Examiners appointed by the University of Mumbai.