AC – 11 July, 2022
Item No. – 6.27 (R)

University of Mumbai

Revised Syllabus for

M.E. - Information Technology

Semester – (Sem. - I to IV)

(REV- 2022 'C' Scheme) from Academic Year 2022 – 23

Under

FACULTY OF SCIENCE & TECHNOLOGY

(With effect from the academic year 2022-23)

University of Mumbai

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**M.E. Information Technology**
2	Eligibility for Admission	**Passed B.E./B.Tech and as per the Ordinance 0.5134**
3	Passing Marks	**45%**
4	Ordinances / Regulations (if any)	**Ordinance 0.5134**
5	No. of Years / Semesters	**2 Years/ 4 semesters**
6	Level	**Post Graduation**
7	Pattern	**Semester**
8	Status	**Revised 2022**
9	To be implemented from Academic Year	**With effect from Academic Year: 2022-2023**

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Semester I

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ME-ITC101	Data Science and Engineering	3	--	--	3	--	--	3
ME-ITC102	Blockchain Technology	3		--	3		--	3
ME-ITPE101X	Program Elective 1	3	--	--	3	--	--	3
ME-ITPE102X	Program Elective 2	3	--	--	3	--	--	3
IE101X	Institute Elective 1	3	--	--	3	--	--	3
ME-ITL101	Program Lab-I	--	2	--	--	1	--	1
ME-ITSBL101	Skill Based Lab-I	--	4$	--	--	2	--	2
Total		**15**	**06**	**--**	**15**	**03**	**--**	**18**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test-1	Test-2	Avg					
ME-ITC101	Data Science and Engineering	20	20	20	80	3	--	--	100
ME-ITC102	Blockchain Technology	20	20	20	80	3	--	--	100
ME-ITPE101X	Program Elective 1	20	20	20	80	3	--	--	100
ME-ITPE102X	Program Elective 2	20	20	20	80	3	--	--	100
IE101X	Institute Elective 1	20	20	20	80	3	--	--	100
ME-ITL101	Program Lab-I	--	--	--	--	--	25	25	50
ME-ITSBL101	Skill Based Lab-I	--	--	--	--	--	50	50	100
Total		**--**	**--**	**100**	**400**	**--**	**75**	**75**	**650**

$ indicates work load of Learner (Not Faculty), for Skill Based Lab

Note 1: Skill Based Lab- I and II shall include activity / project based learning like

1) Mini project in engineering domains related to the specialization or interdisciplinary domains
2) Product Design
3) Application Software Development
4) Idea proposal and validation

 # Program Elective

Every student is required to take one Program Elective Course for Semester I and Semester II. Different sets of courses will run in both the semesters. Students can take these courses from the list of program electives, which are closely allied to their disciplines.

 # Institute Elective

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

Course Code	Program Elective (PE)	Course Code	Institute Elective (IE)
Semester I			
ME-ITPE1011	Ethical Hacking and Digital Forensics	IE1011	Product Lifecycle Management
ME-ITPE1012	Data Preparation and Analysis	IE1012	Reliability Engineering
ME-ITPE1013	Metaverse	IE1013	Management Information System
ME-ITPE1014	Algorithm and Complexity	IE1014	Design of Experiments
ME-ITPE1021	Advances in Software Engineering	IE1015	Operation Research
ME-ITPE1022	Ad-hoc Networks	IE1016	Cyber Security and Laws
ME-ITPE1023	Storage Area Network	IE1017	Disaster Management and MitigationMeasures
ME-ITPE1024	ICT for Social Cause	IE1018	Energy Audit and Management
		IE1019	Development Engineering

Semester II

Course Code	Course Name	Teaching Scheme(Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ME-ITC201	Web X.0	3	--	--	3	--	--	3
ME-ITC202	Cloud Computing and Services	3		--	3		--	3
ME-ITPE201X	Program Elective 3	3	--	--	3	--	--	3
ME-ITPE202X	Program Elective 4	3	--	--	3	--	--	3
IE201X	Institute Elective 2	3	--	--	3	--	--	3
ME-ITL201	Program Lab-II	--	2	--	--	1	--	1
ME-ITSBL201	Skill Based Lab-II	--	4$	--	--	2	--	2
Total		**15**	**06**	**--**	**15**	**03**	**--**	**18**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test-1	Test-2	Avg					
ME-ITC201	Web X.0	20	20	20	80	3	--	--	100
ME-ITC202	Cloud Computing and Services	20	20	20	80	3	--	--	100
ME-ITPE201X	Program Elective 3	20	20	20	80	3	--	--	100
ME-ITPE202X	Program Elective 4	20	20	20	80	3	--	--	100
IE201X	Institute Elective 2	20	20	20	80	3	--	--	100
ME-ITL201	Program Lab-II	--	--	--	--	--	25	25	50
ME-ITSBL201	Skill Based Lab-II	--	--	--	--	--	50	50	100
Total		**--**	**--**	**100**	**400**	**--**	**75**	**75**	**650**

$ indicates work load of Learner (Not Faculty), for Skill Based Lab

Note 1: Skill Based Lab- I and II shall include activity / project based learning like

1) Mini project in engineering domains related to the specialization or interdisciplinary domains
2) Product Design
3) Application Software Development
4) Idea proposal and validation

 # Program Elective

Every student is required to take one Program Elective Course for Semester I and Semester II. Different sets of courses will run in both the semesters. Students can take these courses from the list of program electives, which are closely allied to their disciplines.

 # Institute Elective

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

Subject Code	Program Elective (PE)	**Subject Code**	Institute Elective (IE)
Semester II			
ME-ITPE2011	Web Application Security	IE2011	Project Management
ME-ITPE2012	Machine and Deep Learning	IE2012	Finance Management
ME-ITPE2013	ARVR	IE2013	Entrepreneurship Development and Management
ME-ITPE2014	High Performance Computing	IE2014	Human Resource Management
ME-ITPE2021	Design Thinking	IE2015	Professional Ethics and CSR
ME-ITPE2022	Internet of Everything	IE2016	Research Methodology
ME-ITPE2023	Information Retrieval	IE2017	IPR and Patenting
ME-ITPE2024	Green IT	IE2018	Digital Business Management
		IE2019	Environmental Management

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ME-ITMP301	Major Project: Dissertation -I	--	20	--	--	10	--	10
Total		**00**	**20**	**--**	**00**	**10**	**--**	**10**

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)	Term Work	Pract/ Oral	Total
		Test-1	Test-2	Avg					
ME-ITMP301	Major Project: Dissertation -I	--	--	--	--	--	100	--	100
Total		**--**	**--**	**--**	**--**	--	**100**	**--**	**100**

Online Credit Courses

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ME-ITOCC301	Online Credit Course - I	--	--	--	--	--	--	3
ME-ITOCC301	Online Credit Course - II	--	--	--	--	--	--	3
Total		**--**	**--**	**--**	**00**	**00**	**00**	**06**

Note 2: It is mandatory to complete the Online Credit Courses (OCC) available on NPTEL / Swayam /MOOC or similar platform approved by university. The learner shall opt for one course each from OCC- I and OCC-II. These two courses shall be completed in any semester I or II or III, but not later end of the Semester III. The credits earned withOCC- I and OCC-II shall be accounted in the third semester grade-sheet. The learner shall be allowed to take up thesecourses from his or her institute or organization/ industry where his / her major project is carried out. The students shall complete the courses and shall qualify the exam conducted by the respective authorities/ instructor from the platform. The fees for any such courses and the corresponding examination shall be borne by the learner. University shall make a provision that credit earned with OCC-I and OCC-II shall be accounted in the third semester grade-sheetwith actual names of the courses.

Online Credit Course – I

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

Online Credit Course –II

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

Semester IV

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

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test-1	Test-2	Avg					
ME-ITMP401	Major Project : Dissertation -II	--	--	--	--	--	100	100	200
Total		**--**	**--**	**--**	**--**	**--**	**100**	**100**	**200**

Total Credits: 68

Note 3: The Dissertation submission shall not be permitted till the learner completes all the credit requirements of ME course.

Semester I

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ME-ITC101	Data Science and Engineering	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ME-ITC101	Data Science and Engineering	20	20	20	80	--	--	--	100

Sr. No.	Course Objectives
The course aims:	
1	To know the fundamental concepts of data science
2	To understand the role of basic mathematics and statistics in data science.
3	To understand the EDA process.
4	To introduce students to the basic concepts and techniques of Machine Learning.
5	Explore different methods of data visualization.
6	To enable students to analyze data science methods for real world problems.

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Elaborate the concept of data science and related terminology.	L2
2	Apply the concepts of mathematics and statistics to solve the data science problem.	L3
3	Apply EDA process before using the data.	L3
4	Apply machine learning techniques to solve the real world problems.	L3, L4
5	Identify and use appropriate data visualization technique.	L3
6	Analyze current trends in Data Science and REST API.	L4

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Knowledge of Basic Python/R Programming	02	
I	**An Introduction to Data Science**	**What is data science**? Basic terminology, Why data science?, Example – Sigma Technologies , The data science Venn diagram. **Types of Data**: Structured versus unstructured data, Quantitative versus qualitative data, **The four levels of data:** The nominal level, ordinal level, interval level and ratio level, The Five Steps of Data **Self-LearningTopics:** Applications and Case Studies of Data Science in various Industries	**04**	**CO1**
II	**Mathematics for DS**	**Linear Algebra**: Vector and Matrices **Probability:** Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables **Statistics:** Basic Statistics, what are statistics? How do we obtain and sample data? Obtaining data: Observational and Experimental, Sampling data: Probability sampling, Random sampling, Unequal probability sampling How do we measure statistics: Measures of center, Measures of variation, Measures of relative standing, The insightful part – correlations in data, The Empirical rule **Self-learning Topics:** Explore Pandas and Numpy libraries of Python	**08**	**CO2**
III	**EDA & Feature Engineering**	**Data Wrangling:** Read the data, slicing and dicing the data, filter the data, finding statistical inference, finding missing values, Finding missing values or invalid values, checking if dataset is imbalanced, checking data types- categorical Vs numeric, use of group by function **Data Preparation:** Identifying categorical features and converting their data types, encoding categorical variables, sampling of imbalance dataset, Transformation technique for skewed distributions, scaling and normalization of data	**06**	**CO3**
IV	**Machine learning**	**Learning with Regression:** Linear Regression, Logistic Regression. **Learning with Trees:** Bayes Classification, Decision Trees, Random Forest. **Clustering:** Choosing distance metrics, Different clustering approaches, hierarchical agglomerative clustering, K-means DBSCAN – Relative merits of each method – clustering tendency and quality. **Advanced Algorithm**: Gradient Boosting Algorithm **Self-Learning Topics** : Real world case studies on machine learning	**08**	**CO4**
V	**Data Visualization**	**Data Visualization Need and Importance:** Find distribution features, Identify the outliers, Univariate,	**06**	**CO5**

		bivariate and multivariate analysis, correlation plots. **Data Visualization Options**: Interactive graphics, Plotting: Scatter Plots, Bar Plots, choosing right plots, 3D visualization **Self-Learning Topics** : Explore matplotlib and seaborn library		
VI	**Case Studies in Data Science**	**Case Study 1** – **Predicting stock prices based on social media:** Text sentiment analysis, Exploratory data analysis, Regression route, Classification route **Case Study 2-** The case of Lending club	**05**	**CO6**

Text Books

1. Sinam Ozdemir, "Principles of Data Science", Packt Publication,2016.
2. Davy Cielen, Arno D.B. Meysman, Mohamed Ali, "Introducing Data Science", 2016
3. Ethem Alpaydın, "Introduction to Machine Learning", MIT Press
4. Dan Toomey, "R for Data Science", Packt Publication,2014

References:

1. Tom M.Mitchell, "Machine Learning",McGraw Hill
2. Joel Grus. "Data Science from Scratch. First Principles With Python." O'Reilly Media, 2015.
3. Jake Vander Plas, "Python Data Science Handbook", O'Reilly publication
4. Frank Kane, "Hands-On Data Science and Python Machine Learning", Packt Publication
5. Armando Fandango, "Python Data Analysis", Second Edition, Packt publication.
6. Alberto Boschetti, Luca Massaron, "Python Data Science Essentials Second Edition", Packt Publication

Online References:

1. https://onlinecourses.nptel.ac.in/noc22_cs32/preview
2. https://www.coursera.org/specializations/jhu-data-science
3. https://www.coursera.org/learn/machine-learning
4. https://home.csulb.edu/~jchang9/files/jonathan_guzman_honors_thesis.pdf

Assessment:

Internal Assessment Test:

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

End Semester Examination:

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

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ME-ITC102	Blockchain Technology	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ME-ITC102	Blockchain Technology	20	20	20	80	--	--	--	100

Course Objectives

Sr.No	The course aims:
1	To get acquainted with the concept of Distributed ledger system and Blockchain.
2	To learn the concepts of consensus and mining in Blockchain through the Bitcoin network.
3	To understand Ethereum and develop-deploy smart contracts using different tools and frameworks.
4	To understand permissioned Blockchain and explore Hyperledger Fabric.
5	To understand different types of crypto assets.
6	To apply Blockchain for different domains IOT, AI and Cyber Security.

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Describe the basic concept of Blockchain and Distributed Ledger Technology.	L2
2	Interpret the knowledge of the Bitcoin network, nodes, keys, wallets and transactions.	L3
3	Implement smart contracts in Ethereum using different development frameworks.	L3
4	Develop applications in permissioned Hyperledger Fabric network.	L3
5	Interpret different Crypto assets and Crypto currencies	L3
6	Analyze the use of Blockchain with AI, IoT and Cyber Security using case studies.	L4

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite**	Hash functions, Public – Private keys, SHA, ECC, Digital signatures,	02	
I	**Introduction to DLT and Blockchain**	Fundamental concepts of Distributed systems, Distributed Ledger Technologies (DLTs) Introduction, Types of Blockchains **Blockchain:** Origin, Phases, Components **Block in a Blockchain**: Structure of a Block, Block Header Hash and Block Height, The Genesis Block, Linking Blocks in the Blockchain, Merkle Tree. **Self-learning Topics:** Blockchain Demo	5	CO1
II	**Consensus and Mining**	What is Bitcoin and the history of Bitcoin, Bitcoin Transactions, Bitcoin Concepts: keys, addresses and wallets, Bitcoin Transactions, validation of transactions, PoW consensus **Bitcoin Network**: Peer-to-Peer Network Architecture, Node Types and Roles, Incentive based Engineering, The Extended Bitcoin Network, Bitcoin Relay Networks, Network Discovery, Full Nodes, Exchanging "Inventory", Simplified Payment Verification (SPV) Nodes, SPV Nodes and Privacy, Transaction Pools, Blockchain Forks **Self-learning Topics:** Study and compare different consensus algorithms like PoA, PoS, pBFT	8	CO2
III	**Permissionless Blockchain: Ethereum**	Components, Architecture of Ethereum, Miner and mining node, Ethereum virtual machine, Ether, Gas, Transactions, Accounts, Patricia Merkle Tree, Swarm, Whisper and IPFS, Ethash, End to end transaction in Ethereum, **Smart Contracts**: Smart Contract programming using solidity, Metamask (Ethereum Wallet), Setting up development environment, Use cases of Smart Contract, Smart Contracts: Opportunities and Risk. **Smart Contract Deployment**: Introduction to Truffle, Use of Remix and test networks for deployment **Other Permissionless Blockchain platforms Introduction:** IOTA, Hashgraph, EOS, etc. **Self-learning Topics:** Smart contract development using Java or Python	9	CO3
IV	**Permissioned Blockchain :**	Introduction to Framework, Tools and Architecture of Hyperledger Fabric Blockchain.	7	CO4

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	Hyperledger Fabric	**Components**: Certificate Authority, Nodes, Chain codes, Channels, Consensus: Solo, Kafka, RAFT Designing Hyperledger Blockchain **Other Permissioned Blockchain platforms Introduction:** CORDA, Quoram, etc. **Self-learning Topics:** Fundamentals of Hyperledger Composer		
V	**Crypto assets and Cryptocurrencies**	Fungible and Nonfungible tokens, ERC20 and ERC721 standards, comparison between ERC20 & ERC721, ICO, STO, Different Crypto currencies **Self-learning Topics:** Defi, Metaverse, Types of cryptocurrencies	4	CO5
VI	**Blockchain Applications & Research Areas**	Blockchain in IoT, AI , Cyber Security, **Research Areas**: Interoperability, Privacy, Performance, Oracles, Security of smart contracts and platforms **Self-learning Topics:** Applications of Blockchain in various domains Education, Energy, Healthcare, real-estate, logistics, supply chain	4	CO6

Text Books:

1. "Mastering Bitcoin, PROGRAMMING THE OPEN BLOCKCHAIN", 2nd Edition by Andreas M. Antonopoulos, June 2017, Publisher(s): O'Reilly Media, Inc. ISBN: 9781491954386.
2. Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.
3. Blockchain Technology, Chandramouli Subramanian, Asha A George, Abhillash K. A and Meena Karthikeyen, Universities press.
4. Hyperledger Fabric In-Depth: Learn, Build and Deploy Blockchain Applications Using Hyperledger Fabric, Ashwani Kumar, BPB publications
5. Solidity Programming Essentials: A beginner's Guide to Build Smart Contracts for Ethereum and Blockchain, Ritesh Modi, Packt publication
6. Cryptoassets: The Innovative Investor's Guide to Bitcoin and Beyond, Chris Burniske & Jack Tatar.

Reference:

1. Mastering Blockchain, Imran Bashir, Packt Publishing 2. Mastering Bitcoin Unlocking Digital Cryptocurrencies, Andreas M. Antonopoulos, O'Reilly Media
2. Blockchain Technology: Concepts and Applications, Kumar Saurabh and Ashutosh Saxena, Wiley.
3. The Basics of Bitcoins and Blockchains: An Introduction to Cryptocurrencies and the Technology that Powers Them, Antony Lewis.for Ethereum and Blockchain, Ritesh Modi, Packt publication.
4. Mastering Bitcoin Unlocking Digital Cryptocurrencies, Andreas M. Antonopoulos, O'Reilly Media

Online References:

1. NPTEL courses:
    a. Blockchain and its Applications,
    b. Blockchain Architecture Design and Use Cases

2. www.swayam.gov.in/
3. www.coursera.org
4. https://ethereum.org/en/
5. https://www.trufflesuite.com/tutorials
6. https://hyperledger-fabric.readthedocs.io/en/release-2.2/whatis.h
7. Blockchain demo: https://andersbrownworth.com/blockchain/
8. Blockchain Demo: Public / Private Keys & Signing: https://andersbrownworth.com/blockchain/public-private-keys/

Assessment:

Internal Assessment Test:

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

End Semester Examination:

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

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ME-ITPE1011	Ethical Hacking & Digital Forensics	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ME-ITPE1011	Ethical Hacking & Digital Forensics	20	20	20	80	--	--	--	100

Course Objectives

Sr.No	The course aims:
1	To understand computer forensic technology.
2	To identify types of computer forensic systems.
3	To explore the procedures for identification, preservation, and extraction of digital evidence.
4	To explore the electronic evidence, identification of forensic data.
5	To learn how to investigate attacks on mobile platforms.
6	To explore various hacking techniques.

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the computer forensic technology.	L2
2	To discuss the types of computer forensics systems.	L2
3	Understand the process of collection, analysis and recovery of the digital evidence	L2, L4
4	Understand the process of computer analysis.	L2
5	Identify various security aspects with respect to mobile technology.	L1
6	Understand various hacking tools and techniques.	L2

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
	Prerequisite	Ethical Hacking terminology, Legal implication of hacking, Impact of hacking.	**2**	
I	Overview of computer Forensics Technology	Introduction to computer forensics, use of forensics in law enforcement, employment proceedings, computer Forensics services. Types of computer Forensics Technology- Military, law, spyware and Adware, Biometrics security systems **Self-learning Topics:** Relevant law to combat computer crime –Information Technology Act	**5**	**CO1**
II	Foot Printing & Social Engineering	Information gathering Methodologies, Competitive Intelligence, DNS Enumerations, Social Engineering attacks. Types of Computer Forensics systems: Internet security, IDS, Firewall, Public key. **Self-learning Topics:** Types of IDS and Firewall	**6**	**CO2**
III	Incident and Incident Response and Storage	Introduction to Incident, Incident Response Methodology, Steps, Activities in Initial Response Phase after detection of an incident. Initial Response and Forensic Duplication: Initial Response & Volatile Data Collection from Windows system, Initial Response & Volatile Data Collection from Unix system, Forensic Duplication: Forensic duplication as Admissible Evidence, Forensic Duplication Tool Requirements. Digital Forensics: Introduction – Evidential potential of digital devices: closed vs. open systems, evaluating digital evidence potential, Device handling: seizure issues, device identification, networked devices and contamination. **Self-learning Topics:** dd, WinHex, Helix3Pro	**7**	**CO3**
IV	Network Forensics	Collecting Network Based Evidence, Investigating Routers, Network protocols, Email Tracing, Internet Fraud. **Self-learning Topics:** tcpdump, snort	**6**	**CO4**
V	Mobile Phone Forensics	Crime and mobile phones, evidence, forensic procedures, files present in SIM card, device data, external memory dump, evidences in memory card, operators systems. **Self-learning Topics:** Wireshark, Autopsy, SIFT.	**6**	**CO5**
VI	Hacking	Scanning & Enumeration: Port Scanning, Network Scanning, Vulnerability	**7**	**CO6**

		Scanning, NMAP Scanning tool, OS Fingerprinting, Enumeration. System Hacking: Password cracking techniques, Key loggers, Escalating privileges, Hiding Files, Steganography Technologies, Countermeasures. Sniffers & SQL Injection: Active and passive sniffing, ARP Poisoning, Session Hijacking, DNS Spoofing, Conduct SQL Injection attack, Countermeasures. **Self-learning Topics**: IP Spoofing, Buffer Overflow, Password attacks.		

Text Books:

1. Kevin Mandia, chirs Proise, "Incident Response and Computer Forensic"
2. Marjie T Britz, "Computer Forensics and Cyber Crime: An Introduction", Pearson Education, 2nd Edition
3. Peter Stepheson,"Investigating Computer Crime: A handbook for corporate investigation"
4. Nilakshi Jain, Dhananjay Kalbande, "Digital Forensic: The fascinating world of Digital Evidences" Wiley India Pvt Ltd 2017.

References:

1. Mari E-Helen Maras, "Computer Forensics: Cybercriminals, Laws, and Evidence", Jones & Bartlett Learning; 2nd Edition, 2014.

2. Majid Yar, "Cybercrime and Society", SAGE Publications Ltd, Hardcover, 2nd Edition

3.Cyber Forensics: A Field Manual for Collecting, Examining, and Preserving Evidence of Computer.

4. Handbook of Computer Crime Investigation, edited by Eoghan Casey.

Assessment:

Internal Assessment Test:

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

End Semester Examination:

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

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ME-ITPE1012	Data Preparation and Analysis	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ME-ITPE1012	Data Preparation and Analysis	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To know the fundamental concepts of data science
2	To understand the EDA process.
3	To explore different methods of data visualization.
4	To understand the role of statistics and machine learning in data science.
5	To learn data ethics associated with data management.
6	To enable students to analyze the recent trends in data collection and analysis techniques for real world problem.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the core concept and technologies related with data.	L2
2	Apply EDA process before using the data.	L3
3	Identify and use appropriate data visualization techniques.	L1
4	Apply the concepts of statistics and machine learning techniques to solve the real world problem.	L3
5	Identify the data ethics to be followed while providing solution to real world problem.	L1
6	Analyze recent trends available for data collection and analysis.	L4

DETAILED SYLLABUS:

Module	Detailed Contents	Hrs
1	**Introduction** Introduction to core concepts and technologies, Types of data - Example applications. Applications of Data Science - Recent trends in various data collection and analysis techniques. Self-learning Topics: study applications of data science.	3
2	**Data Gathering and Preparation** Understanding how to create the data set, Data collection methods. Sources of data - Data collection and APIs - Exploring and fixing data - Data storage and management Self-learning Topics: Study and list the different APIs	7
3	**Data Cleaning** Importance of data 'cleaning', validity and quality. Data Quality, Addressing Data Quality Issues, Consistency checking, Heterogeneous and missing data, Data Transformation and Segmentation Self-learning Topics: Identify the issues in data cleaning.	7
4	**Data visualization** Designing visualizations, Visualization Tools(Area Plots, Histograms ,Bar Charts, Pie Charts, Box Plots, Scatter Plots, Waffle Charts, Word Clouds), Visualizing Geospatial Data, visualizing time series data, Importance of data visualization Dashboards Self-learning Topics Case study on data visualization	7
5	**Data Analysis** Introduction-Terminology and concepts - Introduction to statistics - Central tendencies and distributions – Variance - Distribution properties, Basic machine learning algorithms - Linear regression – SVM - Naive Bayes. Self-learning Topics: case study on data analysis	7
6	**Ethics in data management** Principles of data ethics, The Five Cs: consent, clarity, consistency, control (and transparency), and consequences (and harm) Developing ethical and professional safeguards, Doing good data analysis, Owners of the data, Valuing different aspects of privacy, Getting informed consent Self-learning Topics: case study on data management.	8

Text Books

1. Sinam Ozdemir, "Principles of Data Science", Packt Publication,2016.
2. Davy Cielen, Arno D.B. Meysman, Mohamed Ali, "Introducing Data Science", 2016
3. Ethem Alpaydın, "Introduction to Machine Learning", MIT Press
4. Dan Toomey, "R for Data Science", Packt Publication,2014

References:

1. Tom M.Mitchell, "Machine Learning",McGraw Hill
2. Joel Grus. "Data Science from Scratch. First Principles With Python." O'Reilly Media, 2015.
3. Jake Vander Plas, "Python Data Science Handbook", O'Reilly publication
4. Frank Kane, "Hands-On Data Science and Python Machine Learning", Packt Publication
5. Armando Fandango, "Python Data Analysis", Second Edition, Packt publication.
6. Alberto Boschetti, Luca Massaron, "Python Data Science Essentials Second Edition", Packt Publication
7. Katherine O'Keefe, Daragh O Brien, "Ethical Data and Information Management: Concepts, Tools and Methods", Kogan Page

Assessment:

Internal Assessment Test:

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

End Semester Examination:

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

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ME-ITPE1013	Metaverse	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ME-ITPE1013	Metaverse	20	20	20	80	--	--	--	100

Course Objectives

Sr.No	The course aims:
1	To study the concepts of Metaverse.
2	To study Metaverse and Web 3.0, Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), NFT in Blockchain.
3	To study the Metaverse technologies and protocols.
4	To study and identify the required infrastructure for Metaverse.
5	To study various case studies of Metaverse.
6	To study of Metaverse Immersive technology and Interfaces.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	To Understand the concepts of Metaverse.	L2
2	To understand and study Metaverse and Web 3.0, Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), NFT in Blockchain.	L2, L3
3	To Understand the Metaverse technologies and protocols.	L2
4	To Identify the required infrastructure for Metaverse.	L1
5	To Understand different case studies of Metaverse.	L1
6	To Understand Metaverse Immersive technology and Interfaces	L2

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic Concepts of Blockchain Technology.	02	
I	**Introduction:**	What is the Metaverse? Evaluation of Technology: Web, AR VR, 3D spaces, Immersive learning , Blockchain , Decentralised commerce Self-learning Topics: Study different technology in Metaverse with application.	**03**	**CO1**
II	**Fundamental Concepts of AR, VR, MR and Blockchain:**	Building block technology of metaverse , How Gaming + Web 3.0 + Blockchain are Changing the Internet: Future of Internet: How Metaverse is different from Internet, Potential of Metaverse characteristics that characterise metaverse The Different Shapes of the Metaverse: Games, NFTs (assets), Blockchain Protocols, Cryptocurrencies, etc Self-learning Topics: Case study on Metaverse and ARVR	**07**	**CO2**
III	**Metaverse Technologies and Protocols:**	Metaverse technologies, principles, affordances and challenges Blockchain Protocols and Platforms Involved in the Metaverse Metaverse-Related Tokens Blockchain NFT need for metaverse: working principle of blockchain, NFT based virtual assets in metaverse, case study How NFTs are Unlocking the Metaverse Potential working of ERC721 NFT Self-learning Topics: Case study on Metaverse and Blockchain	**06**	**CO3**
IV	**Metaverse Infrastructure:**	Access the metaverse, necessary hardware Understanding Decentraland , native token MANA, creating own Avatar. Using metamask to access Decentraland, owning land to have direct access of metaverse. Self-learning Topics: Case study on Metaverse and Infrastructure	**06**	**CO4**

V	**Case studies of Metaverse:**	Various usecase of metaverse Industries Disrupted by the Metaverse: Fashion, Marketing, Brands, Finance, Gaming, Architecture, Virtual Shows/Concerts, Art Galleries and Museums Virtual Business and market, Investing In the Metaverse and Profit Asset Classes Inside the Metaverse Metaverse Land Ownership - Property Investment Self-learning Topics: Case study on Metaverse application	**07**	**CO5**
VI	**Metaverse Immersive technology and Interfaces:**	3d Reconstruction, AI technology to analyses 3D Scan Virtual Reality (VR) and Augmented Reality (AR), Mixed Reality (MR) and Extended Reality (XR), Metaverse vs VR what is difference, IoT to bridge gap between physical world and internet Metaverse Interfaces: Personal Computer, Mobile Phone, AR Glasses, VR Goggles, Neuralink Self-learning Topics: Case study on Metaverse and MR	**08**	**CO6**

Text & Reference Books:

1. Mystakidis, Stylianos, " Metaverse",Journal=Encyclopedia,2022, https://www.mdpi.com/2673-8392/2/1/31

2. All One Needs to Know about Metaverse: A Complete Survey on Technological Singularity, Virtual Ecosystem, and Research Agenda, Technical Report · October 2021

Online References:

1. **https://www.udemy.com/course/complete-metaverse-course-everything-about-ar-vr-and-nfts/**

Assessment:

Internal Assessment Test:

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

End Semester Examination:

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

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ME-ITPE1014	Algorithm and Complexity	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ME-ITPE1014	Algorithm and Complexity	20	20	20	80	--	--	--	100

Course Objectives

Sr.No	The course aims:
1	To analyze asymptotic performance of algorithms using space and time complexities..
2	To teach problem formulation and problem solving skills and write rigorous correctness proofs for algorithms.
3	To acquire knowledge and gain familiarity with major applied algorithms.
4	To apply important algorithmic design paradigms and methods of analysis.
5	To solve complex problems in real-life applications.
6	To synthesize efficient algorithms in common engineering design situations.

Course Outcomes

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Analyze various algorithms with practical applications along with their resource requirements.	L4
2	Explore advanced design and analysis techniques.	L2, L4
3	Explain major graph algorithms and their analyses.	L2
4	Analyze linear programming and string matching algorithms.	L4
5	. Identify NP-complete problems and offer solutions to solve such problems.	L1
6	Analyze approximation algorithms.	L4

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping

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0	Prerequisite	Role of algorithms in computing Algorithms as a technology	02	
I	Introduction to algorithm and complexity	Design and analysis fundamentals of algorithms Performance analysis and space and time complexities Growth of functions: Asymptotic analysis—Big oh, omega, and theta notations Mathematical background for algorithm and complexity Recurrence equations and method of solving recurrences, i.e., substitution method, recursion-tree method and master method **Self-learning topics:** Probabilistic analysis and randomized algorithms Sorting and order statistics (i.e., heap sort and quick sort)	05	**CO1**
II	Advanced design and analysis techniques	Dynamic programming: Matrix-chain multiplication, longest common subsequence, 0/1 Knapsack problem, Travelling salesman problem Greedy algorithms: An activity-selection problem, elements of the greedy strategy, Huffman codes **Self-learning topics:** Amortized analysis	08	**CO2**
III	Graph algorithms	Introduction Single-source shortest path: Bellman–Ford algorithm, Dijkstra's algorithm All-pairs shortest path: Floyd–Warshall algorithm, Johnson's algorithm for sparse graphs Maximum flow: Flow networks, Ford–Fulkerson algorithm, maximum bipartite matching **Self-learning topics:** Breadth-first search and Depth-first search Minimum spanning trees	08	**C03**
IV	Linear programming and string matching	Linear programming: Standard and slack forms, formulating problems as linear programs, simplex algorithm, duality, and initial basic feasible solution. String matching: Naïve string-matching algorithm, Rabin–Karp algorithm, string matching with finite automata, and Knuth–Morris–Pratt algorithm **Self-learning topics:** DFT and FFT,	08	**C04**

V	NP-completeness	Polynomial time NP-completeness and reducibility NP-complete problems: Clique problem, Hamiltonian-cycle problem **Self-learning topics:** • Polynomial-time verification	04	**C05**
VI	Approximation algorithms	• Vertex-cover problem • Travelling salesman problem • Set-covering problem • Subset-sum problem **Self-learning topics:** • Randomization and linear programming	04	**C06**

Text Books:

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

2. Herbert S. Wilf, "Algorithms and Complexity", University of Pennsylvania, Taylor & Francis Group, 2020.
3. Ellis Horowitz, Sartaj Sahni, and Sanguthevar Rajasekaran, "Computer Algorithms", Computer Science Press.

References:

1. S. K. Basu, "Design Methods and Analysis of Algorithm", PHI.
2. Harsh Bhasin, "Algorithms: Design and Analysis", Oxford University Press.
3. Vijay V. Vazirani, "Approximation Algorithms", Springer.

Online Reference:

1. Design and Analysis of Algorithms, Link: https://nptel.ac.in/courses/106101060

Assessment:

Internal Assessment Test:

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

End Semester Examination:

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

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ME-ITPE1021	Advances in Software Engineering	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of 2 Tests					
ME-ITPE1021	Advances in Software Engineering	20	20	20	80	--	--	--	100

Course Objectives

Sr.No	The course aims:
1	To familiarize students with advance topics in software engineering
2	Understand limitations and advantages of process models
3	Familiarize with agile development
4	Know importance of process improvement
5	Understand software quality
6	Understand software engineering principles

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand different types of process models	L2
2	Apply agile development	L3
3	Analyze requirements for complex projects	L4
4	Create architectural design	L6
5	Evaluate quality of software	L5
6	Understand importance of process improvement	L2

DETAILED SYLLABUS:

Sr. No.	Module	Detailed content	Hours	CO-PO Mapping
	Prerequisite:	Introduction – Basic knowledge of software engineering principles, Programming skills, Proficiency in any programming language.	**02**	
I	Process Models	Generic process Model, Prescriptive process model, Specialized process model. **Self-learning topics:** Personal and Team Process Models	**05**	**CO1**
II	Agile development	What is agile process, Extreme programming, ASD, Scrum, DSDM, Crystel FDD, LSD, AM, AUP **Self-learning topics:** Extreme Programming (XP), Scrum	4	**CO2**
III	Principles that guide practice and Understanding requirements	Core principles, principles thar guide framework activities, Requirements engineering, establishing groundwork, eliciting requirements, building requirements model, negotiating requirements, Validating requirements. **Self-learning topics:** Prioritizing requirements (Kano diagram) - real life application case study.	**4**	**CO3**
IV	Architectural Design	Software architecture, Architectural genres, Architectural styles, Architectural design, Design patterns, Pattern based software design, Architectural patterns, User interface design patterns. **Self-learning topics:** Software Architecture Design Tools	**8**	**CO4**
V	Quality Management	Quality concepts, Review techniques, Software quality assurance, testing strategies, Formal modeling, and verification, product metrics. **Self-learning topics:** Software Testing real life case study using tools like JIRA	**8**	**CO5**
VI	Software process improvement	What is SPI, The SPI process, CMMI, SPI frameworks, SPI ROI, SPI trends, cleanroom software engineering. **Self-learning topics:** Software Process Improvement and Capability Determination (SPICE)	**8**	**CO6**

Textbook

1. Software Engineering, A Practitioner's Approach, Seventh Edition, Roger s. Pressman

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Reference Book.

1. An integrated approach to Software Engineering, Pankaj Jalote
2. Software Engineering, Tenth Edition, Ian Sommerville

Assessment:

Internal Assessment Test:

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

End Semester Examination:

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

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ME-ITPE1022	Adhoc Networks	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of 2 Tests					
ME-ITPE1022	Adhoc Networks	20	20	20	80	--	--	--	100

Course Objectives

Sr.No	The course aims:
1	Understand the basic concepts of ad-hoc networks
2	Explain the MAC Protocols.
3	Be familiar with ad-hoc routing protocol.
4	Gain knowledge of different multicast routing in ad-hoc network
5	Learn the Transport layer– security protocols
6	Be aware of the applications and Recent Developments in Ad Hoc Networks

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Define the basic concepts of ad-hoc networks.	L1
2	Classify and Explain the MAC Protocols.	L2
3	Classify and Explain the ad-hoc routing protocols	L2
4	Describe the different multicast routing in ad-hoc network	L2
5	Describe the Transport layer– security protocols	L2
6	List and Explain applications and Recent Developments in Ad Hoc Networks	L4

DETAILED SYLLABUS:

Sr. No.	Module	Detail Content	Hours	CO Mapping
	Prerequisite:	Introduction – Fundamentals of Wireless Communication Technology – The Electromagnetic Spectrum –Radio Propagation Mechanisms.	**2**	

I	**Introduction**	Wireless Network. Characteristics of the Wireless channel. Cellular and Ad-Hoc Wireless Networks, Applications of Ad-HocWireless Networks/MANET/Wireless Sensor Network/VANET.Wireless Internet Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks. Mobility, Hidden and Exposed terminal Problems, Characteristics of an Ideal Routing Protocol for Ad-Hoc Wireless Networks **Self Study Topic: Read recent articles on top wireless technology trends, 5G**	**7**	**CO1**
II	**Medium access protocols**	MAC Protocols: design issues, goals and classification. Contention based protocols- with reservation, scheduling algorithms, protocols using directional antennas. Multichannel MAC Protocol, Multichannel CSMA MAC Protocol, Power Control MAC Protocol for Ad Hoc Networks IEEE standards: 802.11a, 802.11b, 802.11g, 802.11p, 802.15. HIPER LAN **Self Study Topic: Work on the implementation and evaluation of the MAC protocol standards using a WSM simulation tool**	**8**	**CO2**
III	**Ad hoc routing protocols**	Introduction: Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classifications of Routing Protocols: Table–Driven Routing Protocols – Destination Sequenced Distance Vector (DSDV), Wireless Routing Protocol (WRP), Cluster Switch Gateway Routing (CSGR), Source–Initiated On–Demand Approaches, Ad hoc On– Demand Distance Vector Routing (AODV), Dynamic Source Routing (DSR), Temporally Ordered Routing Algorithm (TORA),Signal Stability Routing (SSR)– Location–Aided Routing (LAR) – Power–Aware Routing (PAR) – Zone Routing Protocol (ZRP). **Self Study Topic: Work on the implementation and evaluation of the Ad hoc routing protocols standards using a WSM simulation tool**s.	**8**	**CO3**

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IV	**Multicast routing in ad-hoc networks**	Introduction – Issues in Designing a Multicast Routing Protocol — Classification of Multicast Routing Protocols – Tree–Based Multicast Routing Protocols– Mesh–Based Multicast Routing Energy–Efficient Multicast Routing Protocol **Self Study Topic: Work on the implementation and evaluation of the Multicast routing in ad-hoc networks using a WSM simulation tool**	**5**	**CO4**
V	**Transport layer– security protocols**	Introduction – Issues in Designing a Transport Layer Protocol for Ad hoc Wireless Networks – Design Goals of a Transport Layer Protocol for Ad hoc Wireless Networks –Classification of Transport Layer Solutions – TCP over Ad hoc Wireless Networks, Security in Ad-hoc Wireless Networks **Self Study Topic:Work on the implementation and evaluation of the Multicast routing in ad-hoc networks using a WSM simulation tool**	**5**	**CO5**
VI	**Applications and Recent Developments in Ad Hoc Networks**	Applications and Opportunities: Academic Environment Applications, Defense Applications, Industrial Environment Applications, Healthcare Applications, Search and Rescue Applications, Vehicular Ad Hoc Networks Highlights of the Most Recent Developments in the Field **Self Study Topic: Read recent articles on Top wireless technology applications and developments.**	**4**	**CO6**

Text book

1. S. Sarkar, T. Basavraju and C. Puttamdappa, “Ad hoc mobile wireless networks principles, protocols and applications” , second edition, CRC Press, 2016.
2. Al-Sakib Khan Pathan, Muhammad Mostafa Monowar, Zubair Md. Fadlullah, “Building Next-Generation Converged Networks: Theory and Practice, CRC Press, 2013.
3. Stefano Basagni, Marco Conti, Silvia Giordano, Ivan Stojmenovic, “Mobile Ad Hoc Networking: The Cutting Edge Directions”, John Wiley 2013.
4. Feng Zhao & Leonidas J. Guibas, “Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007

References

1. C. K. Toh, “Ad Hoc Mobile Wireless Networks Protocols and Systems”, Prentice Hall, PTR,

2001.
2. Charles E. Perkins, “Ad Hoc Networking”, Addison Wesley, 2000
3. C. Siva Ram Murthy and B. S. Manoj, “Ad Hoc Wireless Networks Architectures and Protocols”, Prentice Hall, PTR, 2004
4. Holger Karl & Andreas Willig, " Protocols And Architectures for Wireless Sensor Networks" , John Wiley, 2005

Assessment:
Internal Assessment Test:

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

End Semester Examination:

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

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ME-ITPE1023	Storage Area Network	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ME-ITPE1023	Storage Area Network	20	20	20	80	--	--	--	100

Course Objectives

Sr.No	The course aims:
1	Understand and analyze the basics of storage network, storage technologies and various storage architectures.
2	Define and understand virtualization with respect to storage network.
3	Understand SAN Management and its various aspects.
4	Describe disaster recovery for storage network and understand strategies, parameters and Quality of Service for Business Continuity in storage infrastructure.
5	Understand and analyze security aspects for storage area network.
6	Be aware of the applications and Recent Developments in Ad Hoc Networks

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Explain storage technologies and storage architectures.	L1
2	Describe and apply virtualization in storage network.	L1
3	Apply SAN Management with its various parameters.	L3
4	Understand and apply disaster recovery and Business Continuity in storage network.	L2
5	Understand and apply storage security and its importance.	L2
6	Apply various storage network concepts like Implementation, SAN	L3

	Management, Virtualization, Disaster Recovery and Security to design storage area network for an organization.	

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite**	Basics of Networking and storage devices, Local File systems, Network File systems and file servers, Shared Disk File systems, Direct attached storage (DAS)	**2**	--
I	**Need for Storage Network**	Basics of Storage Network:- Intelligent Storage Systems (ISS), Data protection (RAID implementation methods). RAID arrays ,RAID technologies, RAID levels, RAID impact on disk performance & RAID comparison, SCSI, SAN: FC SAN FC Protocol Stack, IP Storage, Infiniband, Virtual Interfaces, Comparison of NAS, FC SAN and iSCSI SAN. **Self-learning Topics:** Limitations of traditional server centric architecture, Storage centric architecture and its advantages. Network Attached Storage (NAS)	**09**	**CO1**
II	**Storage Virtualization**	Definition, Storage virtualization on block and file level, Storage virtualization on various levels of Storage network, Symmetric and Asymmetric Virtualization. Basics of Software Defined Storage and it's types **Self-learning Topics: VSAN**	**06**	**CO2**
III	**Managing SAN**	Storage Management tasks, What Gets Managed in SAN? Zoning, Virtualization: Allocating Capacity rather than Disk, SAN Management and Quality of online storage device: Storage capacity, Data availability and I/O performance, SAN Management and Asset Utilization, **Self-learning Topics: Storage planning and capacity planning**	**05**	**CO3**
IV	**Business Continuity**	**Strategies of Business Continuity:** High availability, Disaster Recovery, Continuous business operation **Parameters of Business Continuity:** Availability, characteristics of Availability (MTBF,MTTR and MTTF), characteristics	**06**	**CO4**

		of failure (RTO and RPO), Network Recovery Objective (NRO) **Quality of Service for Business Continuity**: Service level Agreements (SLAs),High availability versus disaster recovery, The seven-Tier Model, Tier 0 to Tier 7 **Self-learning Topics: General Conditions, BC Terminology**		
V	**Storage Security**	**Overview of Storage Security**: Define storage security, Storage security framework: Security attributes (Confidentiality, Integrity, Availability, Accountability), **Security Elements:** Assets(Information, Hardware, Software, Network Infrastructure), Threats, Vulnerabilities **Security Controls:** Technical (implemented in hardware, software and firmware), Non-Technical: Administrative(Policies, Standards), FC SAN security, Basic SAN Security Mechanisms, Securing Switch Ports **Self-learning Topics: NAS security**	**06**	**CO5**
VI	**Designing Storage Area Network**	A case study to design a storage area network for an organization considering the following guidelines: SAN Implementation, SAN Management, SAN Virtualization, SAN Disaster Recovery and Security **Self-learning Topics: Study the Storage Area Network Design of your college/industry campus.**	**05**	**CO6**

Text Books:

1. Ulf Troppens, Rainer Erkens, Wolfgang Muller-Friedt, Rainer Wolafka, Nils Haustein, “Storage Networks Explained: Basics and Application of Fibre Channel SAN, NAS, ,iSCSI, Infiniband and FCoE”, Second Edition, Wiley
2. Richard Barker and Paul Massiglia, “Storage Area Network Essentials A Complete Guide to Understanding and Implementing SANs”, Wiley.
3. EMC Education Services, “Information Storage and Management,” Second Edition, Wiley

4. Martin Hosken, "VMware Software-Defined Storage: A Design Guide to the Policy-Driven, Software-Defined Storage Era"

References:

1.Vaishali D. Khairnar and Nilima M. Dongre**,"** Storage Network Management and Retrieval", Wiley
2. Robert Spalding, “Storage Networks: The Complete Reference”, McGraw Hill Education

3. W. Curtis Preston, “Using SANs and NAS”, O‘‘Reilly

Assessment:
Internal Assessment Test:

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

End Semester Examination:

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

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ME-ITPE1024	ICT for Social cause	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ME-ITPE1024	ICT for Social cause	20	20	20	80	--	--	--	100

Course Objectives

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

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	To identify opportunities and challenges for developing ICT systems.	L1
2	To identify and access the ways by which information can be communicated.	L1

3	To identify methods of capturing data securely for developing an ICT system.	L1
4	To store and analyze the data captured and generate knowledge from the raw data.	L4
5	To devise policies and strategies for ICT system.	L4
6	To design various application using ICT,	L6

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Introduction to ICT	2	
I	**Introduction and Basics of ICT**	Review of ICT history and growth, importance of ICT in societal development identifying opportunities for using ICT, learning from failures Drivers and barriers for ICT development ICT in developing countries – opportunities for developments and challenges Creating an ICT – handling text, data and media. **Self-learning Topics**: Application of ICT	4	CO1
II	**Communication Techniques in ICT**	Radio and TV Techniques, Mobile Techniques – CDMA, Mobile wireless WiMAX, Advanced wireless technologies, Bluetooth Satellite Techniques – architecture AND working principles GPS/GPRS Cloud computing –Introduction, cloud services, Cloud service providers, collaborative techniques like sharing ideas through blogs, forums, online communities etc safe transmission of data **Self-learning Topics:** Study different ICT techniques.	8	CO2

III	**Data acquisition in ICT**	Recognition systems RFID,OMR Location recognition Data acquisition process for MEMS devices Sensors – Programming, communication with cloud. Acquiring data from internet and social media. Formation of social groups and interaction analysis Facebook, Twitter, Blogs, Forums, mailing lists etc controlling access to confidential information **Self-learning Topics:** Case study on data acquisition in ICT	7	CO3
IV	**Data and Knowledge Management in ICT**	Data storage and management content management system identity management Knowledge elicitation Knowledge representation and visualization techniques Knowledge Engineering Methodology Auditing knowledge management Data storage and disposal of data Linking knowledge management to business performance **Self-learning Topics:** case study on Data and Knowledge Management in ICT	7	CO4
V	**Defining policies for administering ICT**	ICT policies and e-Strategies, approach to ICT policy formulation and e-Strategy development, e-Readiness assessment, identifying priority areas and developing action plans. National Policy on ICT in India. **Self-learning Topics:** study ICT policy.	6	CO5
VI	**ICT applications**	Study of ICT applications in various domains such as Agriculture, Healthcare, Education, social studies, Finance, Law, life science. **Self-learning Topics:** Study of ICT applicationsin different area.	5	CO6

Text Books:

1. Lechman, E. (2015). ICT Diffusion in Developing Countries: Towards a New Concept of Technological Takeoff. Germany: Springer International Publishing.,

2. Affordability Issues Surrounding the Use of ICT for Development and Poverty Reduction. (2018). United States: IGI Global.

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3. Koh, S. C. L., Maguire, S. (2009). Information and Communication Technologies Management in Turbulent Business Environments. United Kingdom: Information Science Reference.,

4. The Development Dimension ICTs for Development: Improving Policy Coherence. (2010). Ukraine: OECD Publishing.,

5. Gorica, K., Kordha Tolica, E., Sevrani, K. (2015). Information Society Development Through ICT Market Strategies: Albania Versus Other Developing Countries. Germany: Springer International Publishing.

6. ICT Futures :Delivering Pervasive Realtime And Secure Services Edited By Paul Warren , John Davies, David Brown , Wiley Publication

7. ICT Policy Formulation and e-Strategy Development Strategy Development - A Comprehensive Guidebook by Richard Labelle, Asia-Pacific Development Information Programme

Online References:

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

Assessment:

Internal Assessment Test:

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

End Semester Examination:

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

		Teaching Scheme (Contact Hours)			Credits Assigned			
Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical & Oral**	**Tutorial**	**Total**
ME-ITL101	Program Lab-I	--	2	--	--	1	--	01

Course Code	**Course Name**	**Examination Scheme**						
		Theory Marks				**Term Work**	**Practical/ Oral**	**Total**
		Internal assessment			**End Sem. Exam**			
		Test1	**Test 2**	**Avg. of 2 Tests**				
ME-ITL101	Program Lab-I	--	--	--	--	25	25	50

Lab Objectives:

Sr. No	**Lab Objectives**
1	To understand the concept of maths in data science
2	To understand the concept of ML algorithms
3	To understand the concept of data visualization
4	To develop and deploy smart contracts on local Blockchain
5	To deploy smart contracts on Ethereum test network.
6	To develop and publish smart contracts crypto currency

Lab Outcomes:

Sr. No	**Lab Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
1	Understand and apply the concept of maths in Data Science	L1,L2,L3
2	Understand and apply the concept of ML algorithms	L1,L2,L3
3	Understand and apply the concept of data visualization	L1,L2,L3
4	Understand and apply the concept of smart contracts on local Blockchain	L1,L2,L3
5	Understand deploy and publish smart contracts on Ethereum test network	L1,L2,L3,L4
6	Understand develop and pyblish smart contracts	L6

Prerequisite: Computer Networks.

DETAILED SYLLABUS:

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Sr. No.	Module	Detailed Content	Hours	LO Mapping
I	Mathematics for DS	Explore Pandas and Numpy libraries of Python.	**05**	LO1
II	Machine Learning Algorithms	**Learning with Regression:** Linear Regression, Logistic Regression. **Learning with Trees:** Bayes Classification, Decision Trees, Random Forest.	**04**	LO2
III	Data Visualization	**Data Visualization Options**: Interactive graphics, Plotting: Scatter Plots, Bar Plots, choosing right plots, 3D visualization	**04**	LO3
IV	Local Blockchain	Introduction to Truffle, establishing local Blockchain using Truffle.	**05**	LO4
V	Smart Contracts	Solidity programming language, chain code (Java/JavaScript/Go), deployment on Truffle local Blockchain	**04**	LO4,LO5
VI	Deployment and publishing smart contracts on Ethereum test network	Ethereum Test networks (Ropsten/Gorelli/Rinkeby), deployment on test networks, Web3.js/Web3.py for interaction with Ethereum smart contract	**04**	LO6

Text Books:

1. "Mastering Bitcoin, PROGRAMMING THE OPEN BLOCKCHAIN", 2nd Edition by Andreas M. Antonopoulos, June 2017, Publisher(s): O'Reilly Media, Inc. ISBN: 9781491954386.
2. Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.
3. Blockchain Technology, Chandramouli Subramanian, Asha A George, Abhillash K. A and Meena Karthikeyen, Universities press.
4. Sinam Ozdemir, "Principles of Data Science", Packt Publication,2016.
5. Davy Cielen, Arno D.B. Meysman, Mohamed Ali, "Introducing Data Science", 2016
6. Ethem Alpaydın, "Introduction to Machine Learning", MIT Press
7. Dan Toomey, "R for Data Science", Packt Publication,2014

References:

1. Tom M.Mitchell, "Machine Learning",McGraw Hill
2. Joel Grus. "Data Science from Scratch. First Principles With Python." O'Reilly Media, 2015.
3. Jake Vander Plas, "Python Data Science Handbook", O'Reilly publication
4. Frank Kane, "Hands-On Data Science and Python Machine Learning", Packt Publication
5. Armando Fandango, "Python Data Analysis", Second Edition, Packt publication.
6. Alberto Boschetti, Luca Massaron, "Python Data Science Essentials Second Edition", Packt Publication

Online References:

1. https://onlinecourses.nptel.ac.in/noc22_cs32/preview
2. https://www.coursera.org/specializations/jhu-data-science
3. https://www.coursera.org/learn/machine-learning
4. https://home.csulb.edu/~jchang9/files/jonathan_guzman_honors_thesis.pdf

Term Work:

Term Work shall consist of at least 10 practical based on the above list. Also Term Work Journal must include Assignement as mentioned in above syllabus.

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

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

		Teaching Scheme (Contact Hours)			Credits Assigned			
Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical & Oral**	**Tutorial**	**Total**
ME-ITSBL101	DeVops & Adv-DeVops Lab (SBL-I)	--	4	--	--	2	--	02

Course Code	**Course Name**	**Examination Scheme**						
		Theory Marks				**Term Work**	**Practical/ Oral**	**Total**
		Internal assessment			**End Sem. Exam**			
		Test1	**Test 2**	**Avg. of 2 Tests**				
ME-ITSBL101	DeVops & Adv-DeVops Lab (SBL-I)	--	--	--	--	50	50	100

Lab Objectives:

Sr. No	**Lab Objectives**
1	To understand DevOps practices which aims to simplify Software Development Life Cycle
2	To be aware of different Version Control tools like GIT, CVS or Mercurial
3	To Integrate and deploy tools like Jenkins and Maven, which is used to build, test and deploy applications in DevOps environment
4	To understand DevOps practices and cloud native environments to achieve continuous software delivery pipelines and automated operations that address the gap between IT resources and growing cloud complexity.
5	To Use Kubernetes services to structure N-tier applications.
6	To understand that security and speed in software development are not inversely-related objectives Internalizing the contribution of tools and automation in DevSecOps

Lab Outcomes:

Sr. No	**Lab Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
1	To understand the fundamentals of DevOps engineering and be fully proficient with DevOps terminologies, concepts, benefits, and deployment options to meet your business requirements	L1,L2
2	To obtain complete knowledge of the "version control system" to effectively track changes augmented with Git and GitHub	L1,L2
3	To understand the importance of Jenkins to Build and deploy Software Applications on server environment	L1,L2
4	To understand the fundamentals of Cloud Computing and be fully proficient with Cloud based DevOps solution deployment options to meet your business requirements	L1,L2
5	To deploy single and multiple container applications and manage application deployments with rollouts in Kubernetes	L1,L2,L3

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6	To identify and remediate application vulnerabilities earlier and help integrate security in the development process using SAST Techniques.	L1,L2,L3

Prerequisite: Operating System, Linux Administration, Java /Web Application Programming, and Software Engineering.

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DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
I	Introduction to Devops	Understanding of the process to be followed during the development of an application, from the inception of an idea to its final deployment. Learn about the concept of DevOps and the practices and principles followed to implement it in any company's software development life cycle. Learn about the phases of Software Lifecycle. Get familiar with the concept of Minimum Viable Product (MVP) & Cross-functional Teams. Understand why DevOps evolved as a prominent culture in most of the modern-day startups to achieve agility in the software development process **Self-Learning Topics: Scrum, Kanban, Agile**	**04**	LO1
II	Git	In this module you will learn: • GIT Installation, Version Control, Working with remote repository • GIT Cheat sheet • Create and fork repositories in GitHub • Apply branching, merging and rebasing concepts. • Implement different Git workflow strategies in real-time scenarios • Understand Git operations in IDE **Self-Learning Topics: AWS Codecommit, Mercurial, Subversion, Bitbucket, CVS**	**04**	LO1, LO2
III	Continuous Integration using Jenkins	In this module, you will know how to perform Continuous Integration using Jenkins by building and automating test cases using Maven / Gradle / Ant. • Introduction to Jenkins (With Architecture) • Introduction to Maven / Gradle / Ant. • Jenkins Management Adding a slave node to Jenkins • Build the pipeline of jobs using Maven / Gradle / Ant in Jenkins, create a pipeline script to deploy an application over the tomcat server	**04**	LO1, LO3

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		Self-Learning Topics: Travis CI, Bamboo, GitLab, AWS CodePipeline		
IV	DevOps on Cloud	Learn about various cloud services and service providers, also get the brief idea of how to implement DevOps over Cloud Platforms. • Introduction to high availability architecture and auto-scaling • Set up the DevOps infrastructure on the cloud • Work and set up IDE on Cloud9 • Deploy projects on AWS using Code Build, CodeDeploy, and CodePipeline **Self-Learning Topics:** AWS Codestar	**06**	LO4
V	Kubernetes	In this module, you will learn how Kubernetes automates many of the manual processes involved in deploying, managing, and scaling containerized applications. Install and configure Kubernetes Spin Up a Kubernetes Cluster Check the Nodes of Your Kubernetes Cluster Installing kubectl to manage cluster and deploy Your First Kubernetes Application **Self-Learning Topics:** • Using Services and Ingresses to Expose Deployments • Perform logging, monitoring, services, and volumes in Kubernetes.	**04**	LO4,LO5
VI	DevOps Security	In this module, you will learn to identify and remediate application vulnerabilities earlier and help integrate security in the development process using tools like SonarQube / Gitlab / • Perform static analysis on application source code and binaries. • Spot potential vulnerabilities before deployment • Analysis of java / web-based project • Jenkins SonarQube / Gitlab Integration	**04**	LO6

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		Self-Learning Topics: Snyk, OWASP ZAP, Analysis Core Plugin		

Text books

1. DevOps Bootcamp, Sybgen Learning
2. Karl Matthias & Sean P. Kane, Docker: Up and Running, O'Reilly Publication.
3. Len Bass,Ingo Weber,Liming Zhu,"DevOps, A Software Architects Perspective", AddisonWesley-Pearson Publication.
4. John Ferguson Smart," Jenkins, The Definitive Guide", O'Reilly Publication.
5. Mastering Puppet 5: Optimize enterprise-grade environment performance with Puppet, by Ryan Russell-Yates Packt Publishing (September 29, 2018)
6. AWS Certified SysOps Administrator Official Study Guide: Associate Exam by Stephen Cole (Author), Gareth Digby (Author), Chris Fitch (Author), Steve Friedberg (Author), Shaun Qual
7. AWS Certified Solutions Architect Official Study Guide: Associate Exam by Joe Baron
8. Terraform: Up & Running - Writing Infrastructure as Code, Second Edition by Yevgeniy Brikman , O'Reilly
9. Kubernetes: Up and Running - Dive into the Future of Infrastructure, Second Editionby Brendan Burns,O'Reilly
10. Going Serverless with AWS Lambda: Leveraging the latest services from the AWS cloud by Ajay Pherwani , Shroff/X-Team;
11. Learning Nagios, Packt Publishing.

References:

1. Sanjeev Sharma and Bernie Coyne," DevOps for Dummies", Wiley Publication
2. Httermann, Michael, "DevOps for Developers", Apress Publication.
3. Joakim Verona, "Practical DevOps", Pack publication
4. Puppet 5 Essentials - Third Edition: A fast-paced guide to automating your infrastructure by Martin Alfke Packt Publishing; 3rd Revised edition (September 13, 2017)
5. Learning Aws - Second Edition: Design, build, and deploy responsive applications using AWS by Amit Shah Aurobindo Sarkar
6. Mastering Aws Lambda by Yohan Wadia Udita Gupta

Guidelines for Mini Project as per above syllabus.

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement how to contribute to open source mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of recent contribute to open source mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand contribute to open source problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report using open source tools to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the open source Mini Projects.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 30
    - Marks awarded by review committee : 10
    - Quality of Project Report :05

Term Work:

Term Work shall consist of at least 10 practical based on the above list. Also Term Work Journal must include Mini-Project as mentioned in above syllabus.

Term Work Marks: 50 Marks (Total marks) = 45 Marks (Mini-project) + 5 Marks (Attendance)

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

Course Code	Course Name	Credits
IE1011	**Product Life Cycle Management**	**03**

Course Objectives: Students will try :

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

Course Outcomes: Students 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, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:**For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques,	05

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

Assessment:

Internal:
Assessment 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. 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

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Course Code	Course Name	Credits
IE1012	**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:

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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.

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Course Code	Course Name	Credits
IE1013	**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.

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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

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Course Code	Course Name	Credits
IE1014	**Design of Experiments**	**03**

Objectives:

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

Outcomes: Learner will be able to…

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

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 2^2 Design The 2^3 Design The General 2^k Design A Single Replicate of the 2^k Design The Addition of Center Points to the 2^k Design, Blocking in the 2^k Factorial 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

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05	**Response Surface Methods and Designs** Introduction to Response Surface Methodology The Method of Steepest Ascent Analysis of a Second-Order Response Surface Experimental Designs for Fitting Response Surfaces	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 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. 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

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Course Code	Course Name	Credits
IE1015	**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,	05

	Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	
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
IE1016	**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 and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Bot nets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyber line** Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal:
Assessment 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
IE1017	**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: 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 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 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 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	06

	casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	
05	Financing Relief Measures: 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. International relief aid agencies and their role in extreme events.	09
06	Preventive and Mitigation Measures: Pre-disaster, during disaster and post-disaster measures in some events in general Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 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
IE1018	**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 ofsome common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation ofsome common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

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