Vidyalankar Institute of Technology

An Autonomous Institute Affiliated to the University of Mumbai

Scheme and Detailed Syllabus

of

Final Year

Bachelor of Engineering

In

Information Technology

(Curriculum of REV- 2019 'C' Scheme of UoM)
With effect from Academic Year 2022-23

Program Structure for Final Year Information Technology
Vidyalankar Institute of Technology (With Effect from 2022-2023)
Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
ITC701	AI and DS –II	3	--	3	-	3
ITC702	Internet of Everything	3	--	3		3
ITDO701X	Department OptionalCourse – 3	3	--	3	-	3
ITDO702X	Department Optional Course –4	3	--	3	-	3
ITIO701X	Institute Optional Course – 1	3	--	3	-	3
ITL701	Data Science Lab	-	2	-	1	1
ITL702	IOE Lab	-	2	-	1	1
ITL703	Secure Application Development	-	2	-	1	1
ITL704	Recent Open SourceProject Lab	-	2	-	1	1
ITP701	Major Project I	-	$6^{\#}$	-	3	3
Total		**15**	**14**	**15**	**7**	**22**

Evaluation Scheme for Final Year Information Technology
Vidyalankar Institute of Technology (Autonomous status with effect from A.Y. 2022-23)
Semester VII

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITC701	AI and DS –II	20	30	50	100
ITC702	Internet of Everything	20	30	50	100
ITDO701X	Department OptionalCourse – 3	20	30	50	100
ITDO702X	Department Optional Course –4	20	30	50	100
ITIO701X	Institute Optional Course – 1	20	30	50	100
ITL701	Data Science Lab	25	--	25	50
ITL702	IOE Lab	25	--	25	50
ITL703	Secure Application Development	25	--	25	50
ITL704	Recent Open SourceProject Lab	25	--	25	50
ITP701	Major Project I	25	--	25	50
Total		**230**	**160**	**385**	**775**

* Theory class to be conducted for full class and $ indicates workload of Learner (Not Faculty), students can form groups with minimum 2(Two) and not more than 4(Four). Faculty Load: 1hour per week per four groups.

ITDO701X	Department Optional Course –3
ITDO7011	Storage Area Network
ITDO7012	High Performance computing
ITDO7013	Infrastructure Security
ITDO7014	Software Testing and QA

ITDO702X	Department Optional Course –4
ITDO7021	MANET
ITDO7022	AR – VR
ITDO7023	Quantum Computing
ITDO7024	Information Retrieval System

 # Institute Level Optional Course (ILO)

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

ILO701X	Institute Optional Course – 1 (Common for all branches will be notified)
ILO7011	Product Lifecycle Management
ILO7012	Reliability Engineering
ILO7013	Management Information System
ILO7014	Design of Experiments
ILO7015	Operation Research
ILO7016	Cyber Security and Laws
ILO7017	Disaster Management and Mitigation Measures
ILO7018	Energy Audit and Management
ILO7019	Development Engineering

Program Structure for Final Year Information Technology
Vidyalankar Institute of Technology (With Effect from 2022-2023)
Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract.	Theory	Pract.	Tut	Total
ITC801	Blockchain and DLT	3	--	3	--	3	ITC801
ITDO801X	**Department Optional Course – 5**	**3**	**--**	**3**	**--**	**3**	**ITDO801X**
ITDO802X	**Department Optional Course – 6**	**3**	**--**	**3**	**--**	**3**	**ITDO802X**
ITIO801X	**Institute Optional Course – 2**	**3**	**--**	**3**	**--**	**3**	**ITIO801X**
ITL801	Blockchain Lab	--	2	--	1	1	ITL801
ITL802	Cloud computing	--	2	--	1	1	ITL802
ITP801	Major Project II	--	12#	--	6	6	ITP801
Total		**12**	**16**	**12**	**8**	**20**	

Evaluation Scheme for Final Year Information Technology
Vidyalankar Institute of Technology (Autonomous status with effect from A.Y. 2022-23)
Semester VIII

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITC801	Blockchain and DLT	20	30	50	100
ITDO801X	**Department Optional Course – 5**	20	30	50	100
ITDO802X	**Department Optional Course – 6**	20	30	50	100
ITIO801X	**Institute Optional Course – 2**	20	30	50	100
ITL801	Blockchain Lab	25	--	25	50
ITL802	Cloud computing	25	--	25	50
ITP801	Major Project II	100	--	50	150
ITC801	Blockchain and DLT	25	--	25	50
Total		**255**	**120**	**325**	**700**

* Theory class to be conducted for full class and $ indicates workload of Learner (Not Faculty), students can form groups with minimum 2(Two) and not more than 4(Four). Faculty Load: 1hour per week per four groups.

Mini Project 1 and 2 :
Students can form groups with minimum 2 (Two) and not more than 4 (Four)Faculty Load : 1 hour per week per four groups

Major Project 1 and 2 :
Students can form groups with minimum 2 (Two) and not more than 4 (Four) Faculty Load : In Semester VII – ½ hour per week per project group In Semester VIII – 1 hour per week per project group

ITDO801X	Department Optional Course – 5
ITDO8011	Big Data Analytics
ITDO8012	Reinforcement learning
ITDO8013	Simulation and Modeling
ITDO8014	Knowledge management

ITDO802X	Department Optional Course –6
ITDO8021	User Interface Design
ITDO8022	Robotics
ITDO8023	ERP
ITDO8024	Cloud computing and Services

Institute Level Optional Course (ILO)

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

ILO801X	Institute Optional Course – 2 (Common for all branches will be notified)
ILO8011	Project Management
ILO8012	Finance Management
ILO8013	Entrepreneurship Developmentand Management
ILO8014	Human Resource Management
ILO8015	Professional Ethics and CSR
ILO8016	Research Methodology
ILO8017	IPR and Patenting
ILO8018	Digital Business Management
ILO8019	Environmental Management

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
ITC701	AI and DS –II	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITC701	AI and DS –II	20	30	50	100

Prerequisite: AI and DS - 1 (ITC604) , Data Mining & Business Intelligence (ITC601)

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To model a decision making for a new problem in an uncertain domain.
2	To demonstrate Cognitive skills of Artificial Intelligence.
3	To become familiar with the basics of Fuzzy Logic and Fuzzy Systems.
4	To become familiar with Deep Learning Concepts and Architectures.
5	To define and apply metrics to measure the performance of various learning algorithms.
6	To enable students to analyze data science methods for real world problems.

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	Design models for reasoning with uncertainty as well as the use of unreliable information.	L1,L2,L3
2	Analyze the process of building a Cognitive application.	L1,L2,L3,L4
3	Design fuzzy controller system.	L1,L2,L3

4	Apply learning concepts to develop real life applications.	L1,L2,L3
5	Evaluate performance of learning algorithms.	L1,L2,L3,L4,L5
6	Analyze current trends in Data Science.	L1,L2,L3,L4

Detailed Syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Intelligent Agents, Search Techniques, Knowledge and Reasoning, Data Science, Machine Learning.	02	--
I	Uncertainty	Uncertainty in AI, Inference using full joint distributions, Bayes Theorem, the semantics of Bayesian Networks, Inference in Bayesian networks, Decision Theory, Markov Decision Processes. Self-learning Topics: Hidden Markov Model (HMM), Gaussian Mixture Model (GMM).	04	CO1
II	Cognitive Computing	Foundation of Cognitive Computing, Design Principles for Cognitive Systems, Natural Language Processing in Support of a Cognitive System, Representing Knowledge in Taxonomies and Ontologies, Applying Advanced Analytics to Cognitive Computing, The Process of Building a Cognitive Application. Self-learning Topics: Cognitive Systems such as IBM's Watson.	06	CO2
III	Fuzzy Logic & Its Applications	Introduction to Fuzzy Sets, Properties of Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Membership Functions, Fuzzy Relations with Operations and its Properties, Fuzzy Composition: Max-Min Composition, Max-Product Composition, Defuzzification Methods, Architecture of Mamdani Type Fuzzy Control System, Design of Fuzzy Controllers like Domestic Shower Controller, Washing Machine Controller, Water Purifier Controller, etc. Self-learning Topics: Other Fuzzy Composition Operations, Fuzzy Inference System (FIS) & ANFIS.	07	CO3

IV	Introduction to Deep Learning	Introduction to Deep Learning, ANN, Machine Learning Vs Deep Learning, Working of Deep Learning; Convolutional Neural Network: Introduction, Components of CNN Architecture, Properties of CNN, Architectures of CNN, Applications of CNN, Recurrent Neural Network: Introduction, Simple RNN, LSTM Implementation, Deep RNN, Auto encoder: Introduction, Features, Types, Applications of Deep Learning. Self-learning Topics: Restricted Boltzmann Machine (RBM).	08	CO4
V	Advanced ML Classification Techniques	Ensemble Classifiers: Introduction to Ensemble Methods, Bagging, Boosting, Random forests, Improving classification accuracy of Class-Imbalanced Data. Metrics for Evaluating Classifier Performance, Holdout Method and Random Subsampling, Cross-Validation, Bootstrap, Model Selection Using Statistical Tests of Significance, Comparing Classifiers Based on Cost–Benefit and ROC Curves. Self-learning Topics: Introduction to ML (Revision),	06	CO4 CO5
VI	Trends and applications in Data Science	Data Science: applications and case studies, Data science for text, image, video, audio. Data science for Multimodal applications. Self-learning Topics: ImageNet Large Scale Visual Recognition Challenge (ILSVRC).	06	CO6

Text Books:
1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Third Edition, Pearson Education.
2. Judith S. Hurwitz, Marcia Kaufman, Adrian Bowles, "Cognitive Computing and Big Data Analytics", Wiley India, 2015.
3. S.N. Sivanandam, S.N. Deepa, "Principles of Soft Computing", Wiley Publication.
4. Dr. S Lovelyn Rose, Dr. L Ashok Kumar, Dr. D Karthika Renuka, "Deep Learning Using Python", Wiley India, 2020.
5. B. Uma Maheshwari, R. Sujatha, "Introduction to Data Science Practical Approach with R and Python", Wiley India,2021.
6. François Chollet, "Deep Learning with Python", Manning Publications, 2018.
7. Han J, Kamber M, Pei J, "Data Mining Concepts and Techniques", Third Edition, Morgan Kaufmann.

References:
1. Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Publication.
2. Ethem Alpaydin , "Introduction to Machine Learning", PHI Learning Pvt. Ltd.
3. Jon Krohn, Grant Beyleveld, Aglae Bassens, "Deep Learning Illustrated: A Visual, Interactive Guide to ArtificialIntelligence", Pearson Education.
4. Prateek Joshi, "Artificial Intelligence with Python", Packt Publishing.

Online References:

Sr. No.	Website Links
1	https://d2l.ai/index.html
2	https://onlinecourses.nptel.ac.in/noc20_cs62/preview
3	https://onlinecourses.nptel.ac.in/noc22_cs35/preview
4	https://www.coursera.org/specializations/deep-learning
5	https://onlinecourses.nptel.ac.in/noc22_cs56/preview

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC702	Internet of Everything	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITC702	Internet of Everything	20	30	50	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To comprehend Characteristics and Conceptual Framework of IoT.
2	To understand levels of the IoT architectures.
3	To correlate the connection of smart objects and IoT access technologies.
4	To Interpret edge to cloud protocols.
5	To explore data analytics and data visualization on IoT Data.
6	To explore IoT applications.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levelsof attainment asper Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Describe the Characteristics and Conceptual Framework of IoT.	L1,L2
2	Differentiate between the levels of the IoT architectures.	L1,L2,L3,L4
3	Analyze the IoT access technologies.	L1,L2,L3,L4
4	Illustrate various edge to cloud protocol for IoT.	L1,L2,L3
5	Apply IoT analytics and data visualization.	L1,L2,L3
6	Analyze and evaluate IoT applications.	L1,L2,L3,L4

Prerequisite: Python programming, C programing language, Computer Networks

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Ports, Timers ,Programming of controller , How touse IDE to write code of microcontroller, TCP-IP protocol stack	02	
I	Introduction to IoT	Introduction to IoT- Defining IoT, Characteristics of IoT, Conceptual Framework of IoT, Physical designof IoT, Logical design of IoT, Functional blocks of IoT, Brief review of applications of IoT. Smart Object – Definition, Characteristics and Trends **Self-learning Topics:** Hardware and software development tools for - Arduino, NodeMCU, ESP32, Raspberry Pi, for implementing internet of things, Simulators-Circuit.io,Eagle,Tinkercad	04	CO1
II	IoT Architecture	**Drivers Behind New Network Architectures** : Scale,Security,Constrained Devices and Networks ,Data,Legacy Device Support **Architecture :** The IoT World Forum (IoTWF) Standardized Architecture :Layer 1-7, IT and OT Responsibilities in the IoT Reference Model,Additional IoT Reference Models A Simplified IoT Architecture The Core IoT Functional Stack ::Layer 1-3 , Analytics Versus Control Applications , Data VersusNetwork Analytics Data Analytics Versus Business Benefits , Smart Services, **IoT Data Management and Compute Stack** :Fog Computing , Edge Computing ,The Hierarchy ofEdge, Fog, and Cloud **Self-learning Topics:** Brief review of applications of IoT: Connected Roadways , Connected Factory, Smart Connected Buildings , Smart Creatures etc,	06	CO2
III	Principles of Connected Devices and Protocols in IoT	RFID and NFC (Near-Field Communication), Bluetooth Low Energy (BLE) roles, LiFi , WPAN std : 802.15 standards: Bluetooth, IEEE 802.15.4, Zigbee, Z-wave, Narrow Band IoT, Internet Protocol and Transmission Control Protocol, 6LoWPAN, WLAN and WAN , IEEE 802.11, Long-range Communication Systems and Protocols: Cellular Connectivity-LTE, LTE-A, LoRa and LoRaWAN.	08	CO3

IV	Edge to Cloud Protocol	HTTP, WebSocket, Platforms. HTTP - MQTT - .Complex Flows: IoT Patterns: Real-time Clients, MQTT, MQTT-SN, Constrained Application Protocol (CoAP), Streaming Text Oriented Message Protocol (STOMP), Advanced Message Queuing Protocol (AMQP), Comparison of Protocols.	08	CO4
V	IoT and Data Analytics	Defining IoT Analytics, IoT Analytics challenges, IoT analytics for the cloud, Strategies to organize Data for IoT Analytics, Linked Analytics Data Sets,	06	CO5

Textbooks:

1. Arsheep Bahga (Author), Vijay Madisetti, Internet Of Things: A Hands-On Approach Paperback, Universities Press, Reprint 2020
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, IoT Fundamentals Networking Technologies, Protocols, and Use Cases for the Internet of Things CISCO.
3. Analytics for the Internet of Things (IoT) Intelligent Analytics for Your Intelligent Devices.Andrew Minteer,Packet 4.Giacomo Veneri , Antonio Capasso," Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0", Packt

References:

1. Pethuru Raj, Anupama C. Raman, The Internet of Things: Enabling Technologies, Platforms, and Use Cases by , CRCpress,
2. Raj Kamal, Internet of Things, Architecture and Design Principles, McGraw Hill Education, Reprint 2018.
3. Perry Lea, Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security, Packt Publications, Reprint 2018.
4. Amita Kapoor, "Hands on Artificial intelligence for IoT", 1st Edition, Packt Publishing, 2019.
5. Sheng-Lung Peng, Souvik Pal, Lianfen Huang Editors: Principles of Internet of Things (IoT)Ecosystem:Insight Paradigm,Springer

Online Resources:

Sr. No.	Website Name
1.	https://owasp.org/www-project-internet-of-things/
2.	NPTEL: Sudip Misra, IIT Khargpur, Introduction to IoT: Part-1, https://nptel.ac.in/courses/106/105/106105166/
3.	NPTEL: Prof. Prabhakar, IISc Bangalore, Design for Internet of Things, https://onlinecourses.nptel.ac.in/noc21_ee85/preview
4.	Mohd Javaid, Abid Haleem, Ravi Pratap Singh, Shanay Rab, Rajiv Suman,Internet of Behaviors (IoB) and its role in customer services,Sensors International,Volume 2,2021,100122,ISSN 2666-3511,https://doi.org/10.1016/j.sintl.2021.100122

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITL701	Data Science Lab	--	2	--	--	1	--	01

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITL701	Data Science Lab	25	-	25	50

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To apply reasoning for a problem in an uncertain domain.
2	To discuss the solution after building a Cognitive application.
3	To familiarize the students with the basics of Fuzzy Logic and Fuzzy Systems.
4	To familiarize the students with Learning Architectures and Frameworks.
5	To define and apply metrics to measure the performance of various learning algorithms.
6	To enable students to analyze data science methods for real world problems.

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	Implement reasoning with uncertainty.	L1, L2, L3
2	Explore use cases of Cognitive Computing	L1, L2
3	Implement a fuzzy controller system.	L1, L2, L3
4	Develop real life applications using learning concepts.	L1, L2, L3
5	Evaluate performance of applications.	L1, L2, L3, L4
6	Implement and analyze applications based on current trends in Data Science.	L1, L2, L3, L4, L5

Hardware & Software requirements:

Hardware Specifications	Software Specifications
PC with following Configuration 1. Intel Core i3/i5/i7 2. 4 GB RAM 3. 500 GB Hard disk	Python, MySQL or Database Software

Prerequisite: Artificial Intelligence and Data Science-I, Python Programming, Data Mining & Business Intelligence.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
I	Uncertainty in AI	1. Implement Inferencing with Bayesian Network in Python	**02**	LO1
II	Cognitive Computing	2. Building a Cognitive Healthcare application 3. Smarter cities: Cognitive Computing in Government 4. Cognitive computing in Insurance 5. Cognitive computing in Customer Service	**04**	LO2
III	Fuzzy Logic & Its Applications	6. Implementation of Fuzzy Membership Functions. 7. Implementation of fuzzy set Properties. 8. Design of a Fuzzy control system using Fuzzy tool.	**04**	LO3

IV	Introduction to Deep Learning	9. Implementing Deep Learning Applications like
		  a. Image Classification System
		  b. Handwritten Digit Recognition System (like MNIST Dataset)
		  c. Traffic Signs Recognition System.
		  d. Image Caption Generator
			06	LO4

V	Advanced ML Classification Techniques	10. Implementation of supervised learning algorithm like
		  a. Ada-Boosting
		  b. Random forests
		11. Evaluation of Classification Algorithms.
			05	LO4,LO5

VI	Mini-project on trends and applications in Data Science	12. Build text/ image/ video/ audio based DS Applications such as a. Chatbot b. Document Classification c. Sentiment Analysis d. Bounding Box Detection e. Music/Video Genre Classification	**05**	LO6

Text Books:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Third Edition, Pearson Education.
2. Judith S. Hurwitz, Marcia Kaufman, Adrian Bowles, "Cognitive Computing and Big Data Analytics", Wiley India,2015.
3. S.N. Sivanandam, S.N. Deepa, "Principles of Soft Computing", Wiley Publication.
4. Dr. S Lovelyn Rose, Dr. L Ashok Kumar, Dr. D Karthika Renuka, "Deep Learning Using Python", Wiley India, 2020.
5. B. Uma Maheshwari, R. Sujatha, "Introduction to Data Science Practical Approach with R and Python", WileyIndia, 2021.
6. François Chollet, "Deep Learning with Python", Manning Publications, 2018.
7. Han J, Kamber M, Pei J, "Data Mining Concepts and Techniques", Third Edition, Morgan Kaufmann.

References:
1. Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Publication.
2. Ethem Alpaydin , "Introduction to Machine Learning", PHI Learning Pvt. Ltd.
3. Jon Krohn, Grant Beyleveld, Aglae Bassens, "Deep Learning Illustrated: A Visual, Interactive Guide to Artificial Intelligence", Pearson Education.
4. Prateek Joshi, "Artificial Intelligence with Python", Packt Publishing.

Online References:

Sr. No.	Website Links
1	https://wisdomplexus.com/blogs/cognitive-computing-examples/
2	http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning_old/labs/explist.php
3	https://infyspringboard.onwingspan.com/en/app/toc/lex_auth_01329517021677633 9249401_ shared/overview
4	https://infyspringboard.onwingspan.com/en/app/toc/lex_auth_01329500219268300 0841860_ shared/overview
5	https://www.udemy.com/course/ibm-watson-for-artificial-intelligence-cognitive-computing/

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITL702	Internet of Everything Lab	--	2	--	--	1	--	01

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITL702	Internet of Everything Lab	25	-	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	To learn different types of sensors.
2	To design the problem solution as per the requirement analysis done using sensors.
3	To study the basic concepts of programming/sensors/ emulators.
4	To design and implement the mini project intended solution for project based learning.
5	To build and test the mini project successfully.
6	To improve the team building, communication and management skills of the students.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive Levels of Attainment as per Bloom's Taxanomy
On successful completion, of course, learner/student will be able to:		
1	Identify the requirements for the real world problems.	L1,L2
2	Conduct a survey of several available literatures in the preferred field of study.	L1,L2
3	Study and enhance software/ hardware skills.	L1,L2
4	Demonstrate and build the project successfully by hardware/sensor requirements,coding, emulating and testing.	L1,L2,L3
5	To report and present the findings of the study conducted in the preferred domain.	L1,L2,L3,L4
6	Demonstrate an ability to work in teams and manage the conduct of the research study.	L1,L2,L3,L4

Hardware & Software requirements:

Hardware Specifications	Software Specifications
1. Intel Core i3/i5/i7 2. 4 GB RAM 3. 500 GB Hard disk 4. Arduino/ Raspberry Pi kit	Simulator

Prerequisite: Basics of Java and Python Programming, Devops

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Experimentation with Microprocessor and Microcontroller ,Experimentation with python and c	02	
I	Arduino	Introduction to Arduino, Hardware requirements, Software requirements, Arduino Programming Language, Arduino Uno Wired & Wireless connectivity, LCD commands, Serial Communication commands. Program for blinking LED using Arduino. Traffic Light pattern using Arduino. ESP8266 WiFi Module	05	LO1, LO2
II	Raspberry Pi	Introduction to Raspberry Pi, Installation of NOOBS and Raspbian on SD card, Libraries on Raspberry Pi, getting static IP address of Raspberry Pi, Interfacing of Relay, DHT11, DC Motorand LCD with Raspberry Pi.	05	LO1,LO2
III	Contiki OS	Contiki OS : History of Contiki OS, Applications, Features,Communication Components in Contiki OS, Cooja simulator,Running Cooja Simulator,	05	LO3
IV	Cooja Simulator	Using the Contiki OS with the Cooja simulator to program theIoT for broadcasting data from sensors	03	LO5,LO6
V	Protocols and Security withCooja	Understanding of 6LowPAN , COAP and protocol implementation in Cooja . Encryption Decryption techniquesfor IoT	03	LO5,LO6

VI	IoT data to Cloud	Installing the Remote desktop server. Installation of Pi camera, Face recognition, serial peripheral interface using Raspberry Pi.. DHT11 data logger with ThingSpeak/ thingsboard/ AWS/ Azure server .	03	LO4,L06

Text Books:

1. Interconnecting Smart Objects with IP: The Next Internet, Jean-Philippe Vasseur, Adam Dunkels, MorganKuffmann
2. Designing the Internet of Things , Adrian McEwen (Author), Hakim Cassimally
3. Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Dr. OvidiuVermesan, Dr. Peter Friess, River Publishers
4. Internet of Things (A Hands-on-Approach) , Vijay Madisetti , Arshdeep Bahga

References:

1. 6LoWPAN: The Wireless Embedded Internet, Zach Shelby, Carsten Bormann, Wiley
2. Building the internet of things with ipv6 and mipv6, The Evolving World of M2M Communications, DanielMinoli John Wiley & Sons
3. Contiki Cooja User Guide.
4. Fundamentals of Sensor Network Programming: Applications and Technology, By S. Sitharama Iyengar, Nandan Parameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye, Wiley publication.
5. Recent research/white papers

Digital Reference :

1. IoT Analytics -Thingshttps://thingspeak.com
2. https://www.contiki-ng.org/
3. http://www.ideationinstru.com/training.htm

Course Code	Course Name	Teaching Scheme (ContactHours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
ITL703	Secure Application Development	--	2	--	--	1	--	01

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITL703	Secure Application Development	25	-	25	50

Lab Objectives:

Sr. No	Lab Objectives
The Lab experiments aims:	
1	To understand the secure programming of application code.
2	To understand the Owasp methodologies and standards.
3	Understand and Identify main vulnerabilities inherent in applications.
4	Understand how Data Validation and Authentication can be applied for application.
5	Understand how to apply Security at Session Layer Management.
6	Understand how to apply to secure coding for cryptography.

Lab Outcomes:

Sr. No	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Apply secure programming of application code.	L1,L2,L3
2	Understand the Owasp methodologies and standards.	L1,L2,L3
3	Identify main vulnerabilities inherent in applications.	L1,L2,L3
4	Apply Data Validation and Authentication for application	L1,L2,L3,L4,L5
5	Apply Security at Session Layer Management	L1,L2,L3,L4,L5
6	Apply secure coding for cryptography.	L1,L2,L3,L4,L5

Hardware & Software requirements:

Hardware Specifications	Software Specifications
PC with following Configuration 1. Intel Core i3/i5/i7 2. 4 GB RAM 3. 500 GB Hard disk	Web Application, HTML5, CSS3, Java, C, Python, MySQL or Database Software. Internet Connection, Browser, Security tools. SAST tools etc.

- **Prerequisite:** Knowledge of programming languages like java/python/C is required.

Detailed Syllabus:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Programming Language and Web application basic concepts.	02	
I	Introduction to Secure Programming	Introduction to laws, standards and guidelines of cyber security. What do you mean by attacks, types of attacks and statistics of main vulnerabilities? Lab1: Study of different laws and standards of cyber security.	04	LO1
II	Methodologies for developing securecode	Software Development Lifecycle. Risk Analysis. Threat Modeling. Study different SAST (Static Application Security Testing) tools. Study different top 10 methodologies and guidelines of OWASP (Open Web Application Security Project) for the secure application development. Any top 5 OAT. Best eight guidelines for Secure Coding. Understand the flow of Verification testing for secure coding. Lab2: Case study for SDLC. Lab3: Exercise on Threat Modeling. Lab4: Study of SAST Tools (open Source like GitHub, GitLab and so on) and use at least one for practical Lab5: Study and implement at Lab6: Study and implement at least any 5 OAT Denial of Inventory for E-commerce Website..	06	LO2
III	VAPT of Applications	Introduction to the HTTP protocol. Owasp Web Security Testing Guidelines. Tools for VAPT testing. Lab7: Use Burp proxy to test web applications.	04	LO3

IV	Data Validation & Authentication	Guidelines for input data validation (Data type, Data size, Data range, Data Content etc.) and authentication for login page. Types of Authentication attacks. Study different type of	05	LO4
V	Security in Session Layer	Introduction to Session Layer in Web Applications and management. Session Management Best practices according to OWASP. Lab15: Session Management for Web Application.	03	LO5
VI	Secure Coding for cryptography	Overview of cryptography and guidelines for using encryption. Types of cryptography ie symmetric and asymmetric. Hashing Algorithms etc. Lab16: Symmetric and Asymmetric Lab17: Symmetric Encryption and Hashing.	02	LO6

Text & References Books:

1. Fundamental Practice for Secure Software Development.
2. The OWASP Automated Threat Handbook - Web Applications.
3. OWASP Alpha Release Code Review Guide 2.0
4. Secure Programming HOWTO
5. OWASP Quick reference guide

Online References:

Sr. No.	Website Links
1	https://www.udemy.com/course/secure-coding-secure-application-development/
2	https://kirkpatrickprice.com/blog/secure-coding-best-practices/
3	https://owasp.org/www-project-automated-threats-to-web-applications/assets/oats/EN/OAT- 021_Denial_of_Inventory

Course Code	Course Name	Teaching Scheme (ContactHours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
ITL704	Recent Open Source Project Lab	--	2	--	--	1	--	01

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITL704	Recent Open Source ProjectLab	25	-	25	50

Lab Objectives:

Sr. No	Lab Objectives
The Lab experiments aims:	
1	To understand the basic concepts of Open Source Software.
2	To understand the GPL(General Public Licence) and Contribute of Open Source.
3	To Understand Contribute to Open Source in different Operating System.
4	To Understand Contribute to Open Source in different Technologies.
5	To Understand Contribute to Open Source in different Network Management..
6	To Understand Contribute to Open Source in different Applications and Services.

Lab Outcomes:

Sr. No	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand and apply the basic concepts of Open Source Software.	L1,L2,L3
2	Identify the difference between the GPL(General Public Licence) and Contribute to Open Source.	L1,L2,L3
3	Apply and evaluate your knowledge for the Contribute to Open Source in different Operating System.	L1,L2,L3,L4,L5
4	Apply and evaluate your knowledge for the Contribute to Open Source in different Technologies.	L1,L2,L3,L4,L5
5	Apply and evaluate your knowledge for the Contribute to Open Source in different Network Management..	L1,L2,L3,L4,L5

| 6 | Apply and evaluate your knowledge for the Contribute to Open Source in different Applications and Services. | L1,L2,L3,L4,L5 |

Hardware & Software requirements:

Hardware Specifications	Software Specifications
PC with following Configuration 1. Intel Core i3/i5/i7 2. 4 GB RAM 3. 500 GB Hard disk	Internet Connection. Any Operating System. Any technology open source tools/simulator/emulator. Any open source Testing Tools Any open source Network Monitoring Tools. Any open Source Database tools. Any open source Latex report writing tools.

Prerequisite: OS, Programming Language, DBMS, IP, Network.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Basic Concepts of OS, Programming Language, Network and DMBS.	02	--
I	Introduction to OSS	Overview of OSS. Basic Concepts of OSS. Advantages of OSS. Difference between free and open source software. What is GPL and Contribute to Open Source Project. Different ways to contribute.	04	LO1
II	Contribute to Open Source Project.	Overview of Contribute Open Source Project. Steps or Guidelines of Contribute to Open Source Projects : 1. Why to Contribute to open source Project. 2. What do you mean by Contribute Open Source Projects. 3. Identifying the new/existing open source projects to contribute. 4. Submit your contribute to open source.5. Results after submitting your contribute to Open Source.	04	LO2
III	Contribute to Open Source in Operating System.	As per Contribute to Operating System to introduce new OS version, Improve OS by removing bugs, Improve existing Skill sets for growth in career. Interact with Stakeholders for feedback and provide training and mentoring. Start own Startup.	04	LO3

IV	Contribute to Open Source in Technologies.	As per Contribute to various emerging technologies like AI/ML/DL/Blockchain/IoT/Data Analytics/Cyber Security/Andriod/iOS/Flutter/DeVoPs/Virtualization and Cloud Computing etc. To improve technologies.Introduce new version of technologies, Improve technologies by removing bugs, Improve existing Skillsets for growth in career. Interact with Stakeholders and provide training and mentoring. Start own Startup.	04	LO4
V	Contribute to Open Source in Network Management.	As per Contribute to different types of Network and Management Systems like LAN/WAN/MAN/Adhoc Network/Data Centre/Wireless Network/Enterprise Network etc. To improve Networks as a Network administrator. Design own Network as per customer requirements, Improve existing Skill sets for growth in career. Interact with Stakeholders and provide training and mentoring. Start own Startup.	04	LO5
VI	Contribute to Open Source in Application & Cloud Services.	As per Contribute to various Applications or Case studies using Cloud Services etc. To improve applications, remove bugs. Improve existing Skill setsfor growth in career. Interact with Stakeholders and provide training and mentoring. Start own Startup.	04	LO6

Guidelines for Recent Open Source 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/internalcommittee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weeklyactivity 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 multiplesolution 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 areasand demonstrate.
- The solution to be validated with proper justification and report using open source tools to be compiled instandard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship qualitydevelopment within the students through the open source

Mini Projects.

Text & Reference Books:

1. Forge Your Future with Open Source: Build Your Skills. Build Your Network.

   Build the Futureof Technology. 1st Edition

Online References:

Sr. No.	Website Links
1	https://github.com/freeCodeCamp/how-to-contribute-to-open-source
2	https://opensource.guide/how-to-contribute/#why-contribute-to-open-source

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITM701	Major Project – I	--	06	--	--	03	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITM701	Major Project – I	25	-	25	50

Course Objectives
1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcome: Learner will be able to…
1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Major Project
- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three ormore than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weeklyactivity of major project-I and major project-II.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisorcan verify and record notes/comments.
- Faculty supervisor may give inputs to students during major project-I & II activity; however, focus shall beon self-learning.

- Students in a group shall understand problem effectively, propose multiple solution and select best possiblesolution in consultation with guide/ supervisor.

- Students shall convert the best solution into working model using various components of their domain areasand demonstrate.

- The solution to be validated with proper justification and report 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 Major Project, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. MajorProject-I in semester VII and Major Project-II in semesters VIII.

- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Major Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to Scopus paper publications in Journal/Conference or motivate for Copyright or Indian Patent as an extension of the Major Project-1 with suitable improvements/modifications after testing and analysis in even semester. This policy can be adopted on case by case basis.

Review/progress monitoring committee may consider following points for assessment based on either one year major project as mentioned in general guidelines.
One-year project:

- In semester VII entire theoretical solution shall be ready, including components/system selection and cost analysis, building of working prototype. Two reviews will be conducted based on presentation given by students group.
- First shall be for finalization of problem and proposed solution of the problem
- Second shall be on readiness of working and testing of prototype to be conducted.
- In semester VIII expected work shall be procurement of testing and validation of results based on work completed in an odd semester.
- First review is based on improvements in testing and validation results cum demonstration for publication to be conducted.
- Second review shall be based on paper presentation in conference/journal or copyright or Indian patent in last month of the said semester.

Major Project shall be assessed based on following criteria;
1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Innovativeness
6. Cost effectiveness and Societal impact
7. Full functioning of working model as per stated requirements
8. Effective use of skill sets
9. Effective use of standard engineering norms
10. Contribution of an individual's as member or leader
11. Clarity in written and oral communication
12. Cost effectiveness
13. Societal Impact

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.

Major Project shall be assessed based on following points;
1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication
9. Publications in Sem VIII.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDO7011	Storage Area Network	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITDO7011	Storage Area Network	20	30	50	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To provide the knowledge of types Storage Network.
2	To examine NAS technology and its applications in Storage Area Networks.
3	To study Emerging Technologies in SAN.
4	To define backup, recovery, disaster recovery and business continuity in the storage area Network.
5	To learn cloud based storage virtualization technologies in SAN.
6	To understand the logical and physical components of storage infrastructures.

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	Identify the limitations of the client-server architecture and evaluate the need fordata protection and storage centric architectures such as Intelligent storage system.	L1,L2
2	Understand various SAN technologies.	L1,L2
3	Interpret and examine NAS technologies and its application in Storage AreaNetwork.	L1,L2
4	Explain Different I/O Techniques in SAN.	L1,L2
5	Describe Cloud based storage virtualization technologies in SAN.	L1,L2
6	Explain Storage infrastructure management with security.	L1,L2

Prerequisite: Operating System, Computer Organization, Computer Networks.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Components of a Storage System Environment, Disk drive components, RAID levels, Cloud Computing	02	--
I	Introduction to Storage Area Network	**Intelligent Storage Systems (ISS)**, Storage Provisioning, Types of Intelligent Storage Systems **Evolution of Storage System:** Server-Centric IT Architecture and its Limitations, Storage-Centric IT Architecture and its Advantages, SAN & its advantages. **Self-learning Topics:** Case Study on Replacing a server with Storage networks**.**	04	CO1
II	Networked Attached Storage & its Application	**Local File Systems:** File systems and databases, Journaling, Snapshots, Volume manager **Network File Systems, and File Servers:** Network Attached Storage (NAS), Performance bottlenecks in file servers, Acceleration of network file systems, Case study: The Direct Access File System (DAFS), **Shared Disk File Systems:** A case study The General Parallel File System (GPFS), **Applying NAS solution:** NAS workload characterization, applying NAS to departmental workloads, enterprise web workloads, and specialized workloads; Considerations when integrating SN and NAS: Differences and similarities, the need to integrate, future storage connectivity and integration. **Self-learning Topics:** Case study on Successful SAN Deployment steps**.**	07	CO2
III	Storage I/O Techniques	The Physical I/O Path from the CPU to the Storage System, SCSI, The Fibre Channel Protocol Stack, Fibre Channel SAN, IP Storage, Infiniband-based Storage Networks, Fibre Channel over Ethernet (FCoE). **Self-learning Topics: C**ase Study on FCoE SAN.	06	CO3

IV	Backup and Data Archive	**Introduction to Business Continuity:** Information Availability, BC Terminology, BC Planning Lifecycle, Failure Analysis, Business Impact Analysis **Backup and Archive:** Backup Purpose, Backup Considerations, Backup Granularity, Recovery Considerations, Backup Methods ,Backup Architecture, Backup and RestoreOperations, Backup Topologies **Self-learning Topics:** Case Study on Replication strategy	06	CO4
V	Storage Area Network as a Service for Cloud Computing & Virtualization	**Virtualization and the cloud:** Cloud infrastructure virtualization, Cloud platforms, Storage virtualization, SAN virtualization **Virtualization Appliances:** Black Box Virtualization, In-Band Virtualization Appliances, Out-of-Band Virtualization Appliances High Availability for Virtualization Appliances, Appliances for Mass Consumption. **Storage Automation and Virtualization:** Policy-Based Storage Management, Application-Aware Storage Virtualization, Virtualization-Aware Applications. **Self-learning Topics:** Case study on symmetric and asymmetric virtualization in networks.	06	CO5
VI	Securing and Managing storage infrastructure	**Securing and Storage Infrastructure:** Information Security Framework, Risk Triad, Storage Security Domains, Security Implementations in Storage Networking, Securing Storage Infrastructure in Virtualized and Cloud Environments. **Managing the Storage Infrastructure:** Monitoring the Storage Infrastructure, Storage Infrastructure Management activities, Storage Infrastructure Management Challenges, Information Lifecycle Management, Storage Tiering **Self-learning Topics:** Case study on SANManagement and Standards**.**	08	CO6

Text Books:

1. G. Somasundaram, Alok Shrivastava, EMC Educational Services, "Information Storage and Management", WileyIndia.

2. Storage Virtualization, Author: Clark Tom, Publisher: Addison Wesley Publishing Company

3. Ulf Troppens, Wolfgang Muller-Friedt, Rainer Wolafka, "Storage Networks Explained" Wiley Publication

4. "Introduction to Storage Area Networks" Jon Tate, Pall Beck, Hector Hugo Ibarra, Shanmuganathan Kumaravel,Libor Miklas, IBM Redbooks.

References:

1. Richard Barker and Paul Massiglia, ìStorage Area Network Essentials: A Complete Guide to Understanding andImplementing SANsî, Wiley India.
2. Storage Networks: The Complete Reference, by Robert Spalding (Author)
3. "Storage Network Management and Retrieval", Vaishali Khairnar, Nilima Dongre. Wiley

Online References:

1. https://www.itprc.com/ultimate-guide-to-storage-area-networks/
2. https://www.techtarget.com/searchstorage/definition/storage-area-network-SAN
3. https://www.snia.org/educational-library/object-storage-trends-use-cases-2021
4. https://www.sciencedirect.com/topics/computer-science/network-attached-storage
5. https://www.techtarget.com/searchstorage/tip/Understand-your-storage-infrastructure-management
6. https://sites.google.com/site/testwikiforfirstciscolab/shd/14-securing-the-storage-infrastructure
7. https://www.techtarget.com/searchdatabackup/tip/What-is-the-difference-between-archives-and-backups

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDO7012	High Performance Computing	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITDO7012	High Performance Computing	20	30	50	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	Learn the concepts of high-performance computing.
2	Gain knowledge of platforms for high performance computing.
3	Design and implement algorithms for parallel programming applications.
4	Analyze the performance metrics of High Performance Computing.
5	Understand the parallel programming paradigm, algorithms and applications.
6	Demonstrate the understanding of different High Performance Computing tools.

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 fundamentals of parallel Computing.	L1,L2
2	Describe different parallel processing platforms involved in achieving High Performance Computing.	L1,L2,L3
3	Demonstrate the principles of Parallel Algorithms and their execution.	L1,L2,L3
4	Evaluate the performance of HPC systems.	L1,L2,L3,L4
5	Apply HPC programming paradigm to parallel applications.	L1,L2,L3
6	Discuss different current HPC Platforms.	L1,L2

Prerequisite: Computer Organization, C Programming, Data structures and Algorithm Analysis.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Computer Organization, C Programming, Data structures and Algorithm Analysis.	02	--
I	Introduction	**Introduction to Parallel Computing:** Motivating Parallelism, Scope of Parallel Computing, Levels of parallelism (instruction, transaction, task, thread, memory, function), Models (SIMD, MIMD, SIMT, SPMD, Dataflow Models, Demand-driven Computation). **Self-learning Topics:** Parallel Architectures: Interconnection network, Processor Array, Multiprocessor.	05	CO1
II	Parallel Programming Platforms	**Parallel Programming Platforms:** Implicit Parallelism: Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines. **Self-learning Topics:** Trends in Microprocessor & Architectures, Limitations of Memory System Performance.	04	CO2
III	Parallel Algorithm And Concurrency	**Principles of Parallel Algorithm Design:** Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Basic Communication operations: Broadcast and Reduction Communication types. **Self-learning Topics: Parallel Algorithm Models**	09	CO3
IV	Performance Measures for HPC	**Performance Measures:** Speedup, execution time, efficiency, cost, scalability, Effect of granularity on performance, Scalability of Parallel Systems, Amdahl's Law, Gustavson's Law. **Self-learning Topics:** Performance Bottlenecks.	05	CO4

V	Programming Paradigms for HPC	**Programming Using the Message-Passing Paradigm :** Principles of Message Passing Programming, The Building Blocks: Send and Receive Operations, MPI: the Message Passing Interface, Topology and Embedding. **Parallel Algorithms and Applications :** One-Dimensional Matrix-Vector Multiplication, Graph Algorithms, Sample Sort, Two-Dimensional Matrix Vector Multiplication. **Self-learning Topics:** Introduction to OpenMP.	09	CO5
VI	General Purpose Graphics Processing Unit(GPGPU) Architecture and Programming	OpenCL Device Architectures, Introduction to OpenCL Programming. **Self-learning Topics:** Introduction to CUDA architecture, andIntroduction to CUDA Programming.	05	CO6

Text Books:

1. AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar , "Introduction to Parallel Computing", PearsonEducation, Second Edition, 2007.
2. Kai Hwang, Naresh Jotwani, "Advanced Computer Architecture: Parallelism, Scalability,Programmability",McGraw Hill, Second Edition, 2010.
3. Edward Kandrot and Jason Sanders, "CUDA by Example – An Introduction to General Purpose GPUProgramming", Addison-Wesley Professional ©, 2010.
4. Georg Hager, Gerhard Wellein, "Introduction to High Performance Computing for Scientists and Engineers",Chapman & Hall / CRC Computational Science series, 2011.
5. Benedict Gaster, Lee Howes, David Kaeli, Perhaad Mistry, Dana Schaa , "Heterogeneous Computing with OpenCL" , 2nd Edition, Elsevier, 2012.

References Books:

1. Michael J. Quinn, "Parallel Programming in C with MPI and OpenMP", McGraw-Hill International Editions,Computer Science Series, 2008.
2. Kai Hwang, Zhiwei Xu, "Scalable Parallel Computing: Technology, Architecture, Programming", McGraw Hill,1998.
3. Laurence T. Yang, MinyiGuo, "High- Performance Computing: Paradigm and Infrastructure" Wiley, 2006.
4. Fayez Gebali, "Algorithms and Parallel Computing", John Wiley & Sons, Inc., 2011.

Online References:

Sr. No.	Website Name
1.	https://onlinecourses.nptel.ac.in/noc21_cs46/preview
2.	https://onlinecourses.nptel.ac.in/noc22_cs21/preview

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDO7013	Infrastructure Security	03	--	-	03	--	-	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITDO7013	Infrastructure Security	20	30	50	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand underlying principles of infrastructure security.
2	To explore software vulnerabilities, attacks and protection mechanisms to learn security aspects of wirelessnetwork infrastructure and protocols.
3	To investigate web server vulnerabilities and their countermeasures.
4	To investigate cloud infrastructure vulnerabilities and their countermeasures.
5	To learn the different attacks on Open Web Applications and Web services.
6	To learn the different security policies.

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 concept of vulnerabilities, attacks and protection mechanisms.	L1,L2
2	Analyze and evaluate software vulnerabilities and attacks on databases andoperating systems.	L1,L2,L3
3	Explain the need for security protocols in the context of wireless communication.	L1,L2,L3
4	Understand and explain various security solutions for Cloud infrastructure.	L1,L2
5	Understand, and evaluate different attacks on Open Web Applications and Web services.	L1,L2
6	Design appropriate security policies to protect infrastructure components.	L1,L2,L3

Prerequisite: Computer Networks, Cryptography and Network Security

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic of OSI Model, Topology's and Computer Networks, Cryptography and Network Security.	02	--
I	Introduction	Cyber-attacks, Vulnerabilities, Defense Strategies and Techniques, Authentication Methods- Password, Token and Biometric, Access Control Policies and Models (DAC,MAC, RBAC, ABAC, BIBA, Bell La Padula), **Self-Learning Topics:** Authentication and Access ControlServices- RADIUS, TACACS, and TACACS+	04	CO1
II	Software Security	**Software Vulnerabilities:** Buffer overflow, Format String, Cross-Site Scripting, SQL Injection, Malware: Viruses, Worms, Trojans, Logic Bomb, Bots, Rootkits **Operating System Security:** Memory and Address Protection, File Protection Mechanism, User Authentication. **Database Security:** Database Security Requirements, Reliability and Integrity,Sensitive Data, Inference Attacks, Multilevel Database Security **Self-Learning Topics:** Format String**,** File System Security (Windows and Linux OS)	08	CO2
III	Wireless Security	Mobile Device Security- Security Threats, Device Security, IEEE 802.11xWireless LAN Security, VPN Security, Wireless Intrusion Detection System (WIDS) **Self-Learning Topics:** Wireshark, Cain and Abel, Aircrack.	06	CO3
IV	Cloud Security	Cloud Security Risks and Countermeasures, Data Protection in Cloud, Cloud Application Security, Cloud Identity and Access Management, Cloud Security asa Service. **Self-Learning Topics:** Metasploit, Ettercap.	06	CO4
V	Web Security	Web Security Considerations, User Authentication and Session Management, Cookies, SSL, HTTPS, SSH, Privacy on Web, Web Browser Attacks, Account Harvesting, Web Bugs, Clickjacking, Cross- Site Request Forgery, Session Hijacking and Management, Phishing and Pharming Techniques, DNS Attacks, Web Service Security, Secure Electronic	08	CO5

		Transaction, Email Attacks, Web Server Security as per OWASP, Firewalls. Self-Learning Topics: Penetration Testing tools: SQL Map, Wapiti.		
VI	Information Security and Risk Management	Security Policies, Business Continuity Plan, Risk Analysis, Incident Management, Legal System and Cybercrime, Ethical Issues in Security Management. Self-Learning Topics: The Indian IT Act, Indian Cyber Law	05	CO6

Text Books:

1. Computer Security Principles and Practice, William Stallings, Sixth Edition, Pearson Education
2. Security in Computing, Charles P. Pfleeger, Fifth Edition, Pearson Education
3. Network Security and Cryptography, Bernard Menezes, Cengage Learning
4. Network Security Bible, Eric Cole, Second Edition, Wiley

References Books:

1. Web Application Hackers Handbook by Wiley.
2. Computer Security, Dieter Gollman, Third Edition, Wiley
3. CCNA Security Study Guide, Tim Boyle, Wiley
4. Introduction to Computer Security, Matt Bishop, Pearson.
5. Cloud Security and Privacy, Tim Mather, Subra Kumaraswamy, Shahed Latif , O'Riely
6. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi

Online References:
1. https://www.cousera.org
2. https://nptel.ac.in

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO7014	Software Testing and QA	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITDO7014	Software Testing and QA	20	30	50	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To provide students with knowledge in Software Testing techniques.
2	To provide knowledge of Black Box and White Box testing techniques.
3	To provide skills to design test case plans for testing software.
4	To prepare test plans and schedules for testing projects.
5	To understand how testing methods can be used in a specialized environment.
6	To understand how testing methods can be used as an effective tool in providing quality assurance concerning software.

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	Investigate the reason for bugs and analyze the principles in software testing toprevent and remove bugs.	L1, L2, L3
2	Understand various software testing methods and strategies.	L1, L2
3	Manage the testing process and testing metrics.	L1, L2, L3
4	Understand fundamental concepts of software automation and use automationtools.	L1, L2
5	Apply the software testing techniques in the real time environment.	L1, L2. L3
6	Use practical knowledge of a variety of ways to test software and quality attributes.	L1, L2

Prerequisite: Programming Language (C++, Java), Software Engineering

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Software Engineering Concepts, Basics of programmingLanguage	**02**	
I	Testing Methodology	Introduction, Goals of Software Testing, Software Testing Definitions, Model for Software Testing, Effective Software Testing vs Exhaustive Software Testing, Software Failure Case Studies, Software Testing Terminology, Software Testing Life Cycle (STLC), Software Testing methodology, Verification and Validation, Verification requirements, Verification of high level design, Verification of low level design, validation. **Self-learning Topics:** Study any system/application, find requirement specifications and design the system. Select software testing methodology suitable to the application.	**07**	CO1
II	Testing Techniques	Dynamic Testing: Black Box Testing: Boundary ValueAnalysis, Equivalence Class Testing, State Table Based testing, Cause-Effect Graphing Based Testing, Error Guessing. White Box Testing Techniques: need, Logic Coverage Criteria, Basis Path Testing, Graph Matrices, Loop Testing,Data Flow testing, Mutation testing. Static Testing. Validation Activities: Unit validation, Integration, Function, System, Acceptance Testing. Regression Testing: Progressive vs. Regressive, Regression Testing, Regression Testability,Objectives of Regression Testing, Regression Testing Types, Define Problem, Regression Testing Techniques. **Self-learning Topics:** Select the test cases (positive andnegative scenarios) for the selected system and Design Test cases for the system using any two studied testing techniques.	**09**	CO2

III	Managing the Test Process	Test Management: test organization, structure and of testing group, test planning, detailed test design and testSpecification. Software Metrics: need, definition andClassification of software matrices. Testing Metrics for Monitoring and Controlling the Testing Process: attributes and corresponding metrics, estimation model for testing effort, architectural design, information flow matrix used for testing, function pointand test point analysis. Efficient Test Suite Management: minimizing the test suite and its benefits, test suite minimization problem, test suite prioritization itstype , techniques and measuring effectiveness. **Self-learning Topics:** Design quality matrix for your selected system	**08**	CO3
IV	Test Automation	Automation and Testing Tools: need, categorization, selection and cost in testing tool, guidelines for testing tools. Study of testing tools: JIRA, Bugzilla, TestDirector and IBM Rational Functional Tester, Selenium etc. **Self-learning Topics:** Write down test cases, execute andmanage using studied tools	**05**	CO4
V	Testing for specialized environment	Agile Testing, Agile Testing Life Cycle, Testing in Scrum phases, Challenges in Agile Testing Testing Web based Systems: Web based system, web technology evaluation, traditional software and web based software, challenges in testing for web based software, testing web based testing **Self-learning Topics:** Study the recent technical papers on software testing for upcoming technologies (Mobile, Cloud, Blockchain, IoT)	**04**	CO5
VI	Quality Management	Software Quality Management, McCall's quality factors and Criteria, ISO9000:2000, SIX sigma, Software quality management **Self-learning Topics:** Case Studies to Identify Quality Attributes Relationships for different types of Applications (Web based, Mobile based etc.)	**04**	CO6

Text Books:

1. Software Testing Principles and Practices Naresh Chauhan Oxford Higher Education
2. Software Testing and quality assurance theory and practice by
Kshirasagar Naik, PriyadarshiTripathy , Wiley Publication

References Books:

1. Effective Methods for Software Testing , third
edition by Willam E. Perry, WileyPublication
2. Software Testing Concepts and Tools by Nageswara Rao Pusuluri , Dreamtech press

Online References:
1. www.swayam.gov.in
2. www.coursera.org
3. http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1099 -1689
4. https://onlinecourses.nptel.ac.in/noc17_cs32/preview
5. https://www.youtube.com/channel/UC8w8_H_1uDfi2ftQx7a64uQ

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO7021	Mobile Ad- hoc Network	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITDO7021	Mobile Ad- hoc Network	20	30	50	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To identify and distinguish major issues associated with ad-hoc networks.
2	To analyze the basic concepts for designing a routing protocol for MANETs.
3	To explore and analyze routing protocols of Ad-hoc network.
4	To learn the concepts of Transport layer and Security issues for MANETs.
5	To apply fundamental principles characteristics of QoS and understand the need of Energy Management in wireless ad-hoc network.
6	To learn the basic concepts of Sensor Networks for Communication in Mobile Ad-hoc network.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
1	Understand the fundamentals of Mobile ad-hoc Networks.	L1,L2
2	Understand and be able to use advanced concept of MAC layer protocols more effectively.	L1,L2
3	Analyse different routing technologies for designing a routing protocol.	L1,L2,L3,L4
4	Understand the concepts of Transport layer and security features of Ad-hoc network.	L1,L2
5	Create the awareness of QoS and Energy Management in Ad hoc network.	L6
6	Demonstrate the ability of wireless sensor network.	L2,L3,L4

Prerequisite: Wireless Technology.

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Fundamentals of Wireless Communication, Wireless Metropolitan and Local Area Networks: IEEE 802.16 (WiMax) – Mesh mode, IEEE 802.11(Wi-Fi) – Architecture, Wireless Ad hoc Networks: WPAN Device Architecture, Wireless Sensor Network Applications, Advantages and Limitations, Wireless Network Security: Security in GSM; UMTS Security; Bluetooth Security;WEP.	**02**	--
I	Introduction to Ad-hoc Wireless Networks	Introduction: Cellular and Ad Hoc Wireless Networks, Applications of Ad Hoc Wireless Networks, Issues In Ad Hoc Wireless Networks: Medium Access Scheme, Routing, Multicasting, Transport Layer Protocols, Pricing, Quality of Service Provisioning, Addressing and Service Discovery, Energy Management, Scalability, Deployment Considerations, Ad Hoc Wireless Internet **Self-learning Topics:** Global Mobile Ad Hoc NetworkMarket	**05**	CO1
II	Medium Access Control Protocols	Issues in Designing a MAC Protocol, Design Goals of MAC Protocols, Classification of MAC protocols, Contention-Based Protocols with Reservation Mechanisms and Scheduling Mechanisms, IEEE 802.11aand HiperLan standard **Self-learning Topics:** MAC Protocols that use Directional Antennas and OtherMAC Protocols	**07**	CO2
III	Routing Protocols	**Routing Protocols in Ad-hoc Wireless Networks:** Introduction, Design issues, Classification of Routing Protocols: Routing information update mechanism, Use of temporal information for routing, Routing topology, Utilization of specific resources, **Multicast Routing in Ad-hoc Wireless Networks**: Introduction, Design Issues, Operation of Multicast Routing Protocols, An Architecture Reference Model for Multicast Routing Protocols **Self-learning Topics:** Table Driven Routing Protocols, Classifications of Multicast Routing Protocols	**08**	CO3

IV	Transport Layer and Security Protocols	**Transport Layer in Ad-hoc Wireless Networks**: Introduction, Design Issues and Goals of a TransportLayer Protocol; Classification of Transport Layer Solutions. **Security in Ad-hoc Wireless Networks:** Issues andChallenges in Security Provisioning, Network Security Attacks classification. **Self-learning Topics:** TCP over Transport Layer Solutions, Key Managementand Secure Touting	**07**	CO4
V	Quality of Service and Energy Management	**Quality of Service in Ad-hoc Wireless Networks**: Introduction, Issues and Challenges in Providing QoS in Ad-hoc Wireless Networks, Classification of QoS Solutions **Energy Management in Ad-hoc Wireless Networks**: Introduction, Need for Energy Management in Ad-hocWireless Networks, Classification of Energy Management Schemes **Self-learning Topics:** MAC Layer Solutions Battery Management Schemes	**06**	CO5
VI	Wireless Sensor Networks	Introduction, Sensor Network Architecture, Data Dissemination, Data Gathering **Self-learning Topics:** Location Discovery and Quality of a Sensor Network	04	CO6

Text Books:

1. C. S. Ram Murthy, B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols", Prentice Hall of India, 2nd Edition, 2005
2. C. K. Toh, "Adhoc Mobile Wireless Networks", Pearson Education, 2002
3. Wireless Communications & Networks, By William Stallings, Second Edition, Pearson Education

References Books:

1. Shih-Lin Wu Yu-Chee Tseng, "Wireless Ad Hoc Networking: Personal-Area, Local-Area, and the Sensory-AreaNetworks", Auerbach Publications, 2007
2. Subir Kumar Sarkar, "Adhoc Mobile Wireless Network: Principles, Protocols and Applications" CRC Press
3. Prashant Mohapatra and Sriramamurthy, "Ad Hoc Networks: Technologies and Protocols", Springer International Edition,2009

Online References:
1. https://www.cousera.org
2. https://nptel.ac.in

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO7022	ARVR	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITDO7022	ARVR	20	30	50	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand the concepts of Augmented Reality and related technologies.
2	To understand the AR tracking system and use of computer vision in AR/MR.
3	To describe the technology for multimodal user interaction and authoring in AR.
4	To understand primitives of computer graphics fundamental.
5	To analyze various Hardware devices suitable for VR.
6	To analyze visual physiology and issues related to it.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels ofattainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Identify and compare different Augmented Reality and Mixed Reality Technologies.	L1, L2
2	Apply concepts of Computer Vision for tracking in AR and MR Systems.	L3
3	Model different interfaces and authoring in AR/MR.	L3
4	Solve Computer Graphics Problems.	L1
5	Analyze application of VR hardware and software components.	L1, L2, L3
6	Identify issues related to visual physiology.	L1, L2

Prerequisite: Programming Language, Computer Graphics, Virtual Reality

DETAILED SYLLABUS:

Module	Title	Description	Hours	CO
0	Pre-requisite	Basics of Computer Graphics, Coordinate Systems, VR Introduction,Tracking in VR	**02**	--
I	Introduction to Augmented Reality andMixed Reality	Definition and Scope, A Brief History of Augmented Reality, AR Architecture, Related Fields of AR (like Mixed Reality, Virtual Reality,Immersive Reality, Extended Reality) and Their comparison, General Architecture of Mixed Reality System, Algorithm Steps in Mixed Reality **Self-Learning Topics**: How AR/MR are related to UbiquitousComputing, Multidimensional Systems.	**04**	CO1
II	Tracking and Computer Vision for ARand MR	Multimodal Displays; Visual Perception; Spatial Display Model; Visual Displays; Tracking, Calibration and Registration; Coordinate Systems; Characteristics of Tracking Technology; Stationary Tracking Systems; Mobile Sensors; Optical Tracking; Sensor Fusion; Marker Tracking; Multiple Camera Infrared Tracking; Natural Feature Tracking by Detection; Incremental Tracking; Simultaneous Localization andTracking; Outdoor Tracking **Self-Learning Topics**: Indoor Tracking, Full Body Tracking	**06**	CO2
III	Interaction, Modeling and Annotation and Authoring	Output Modalities, Input Modalities, Tangible Interfaces, Virtual User Interfaces on Real Surfaces, Multi-view Interfaces, Haptic Interaction, Multimodal Interaction, Specifying Geometry, Specifying Appearance, Semi-automatic Reconstruction, Free-form Modeling, Annotation, Requirement of AR Authoring, Elements of Authoring, Stand-alone Authoring Solutions, Plug-in Approaches, Web Technology **Self-Learning Topics**: Case Study on Object Annotation in Real Time,Avatar Modeling.	**06**	CO3
IV	Geometry of Virtual World	Geometric Modeling, 2D transformations, Homogenous coordinatesystem, 3D rotation and 6 degree of freedom, Viewport Transformation **Self:** Eye Transformation, demo of 2D transformation	**08**	CO4
V	Introduction toVR	Introduction to VR and definitions and its components.,Hardware components: Display devices: LCD, OLED Audio: Speakers, Earphones, Bone conduction Touch: Haptic Device GPU and CPU, Input devices like game controller, data glows,Joysticks Tracking Hardware: Industrial measurement Unit-IMU, Gyroscope,accelerometer Software component: Java3D, VRML **Self:** Feedback mechanisms inVR environment	**07**	CO5

VI	Visual Physiology, perception andtracking	Functioning of Eye with photoreceptors, Resolution for VR, Eye movements and issues with it in VR, Neuroscience of vision, Depth and motion perception, Frame rates and display, Orientation tracking,tilt and yaw drift correction, Tracking with camera **Self:** Light House approach	**06**	CO6

Textbooks:

1. Dieter Schmalsteig and Tobias Hollerer, "Augmented Reality- Principles and Practice", Pearson Education, Inc.2016 Edition.
2. Chetankumar G Shetty, "Augmented Reality- Theory, Design and Development", Mc Graw Hill, 2020 Edition.
3. Alan B. Craig, "Understanding Augmented Reality – Concepts and Applications", Morgan Kaufmann, Elsevier,2013 Edition.
4. . Hearn and Baker, "Computer Graphics- C version", 2nd edition, Pearson, 2002.
5. . R. K Maurya, "Computer Graphics with Virtual Reality", 3rd Edition, Wiley India, 2018.
6. . Steven M. LaVelle," Virtual Reality", Cambridge University press, 2019
7. . Grigore Burdea, Philippe Coiffet, "Virtual Reality Technology", 2nd Edition, Wiley India, 2003
8. . Vince, "Virtual Reality Systems", 1st Edition, Pearson Education, 2002

References Books:

1. Borko Furht, "Handbook of Augmented Reality", Springer, 2011 Edition.
2. Erin Pangilinan, Steve Lukas, and Vasanth Mohan, "Creating Augmented and Virtual Realities- Theory and Practice forNext-Generation Spatial Computing", O'Reilly Media, Inc., 2019 Edition.
3. Jens Grubert, Dr. Raphael Grasset, "Augmented Reality for Android Application Development", PACKT Publishing, 2013 Edition.
4. George Mather, "Foundations of Sensation and Perception", Psychology Press book; 3rd Edition, 2016
5. Tony Parisi, " Learning Virtual Reality", 1st edition, O'Reilly, 2015
6. Alan Craig and William Sherman," Understanding virtual reality: Interface, application and design", 2nd Edition, Morgan Kaufmann Publisher, 2019
7. Peter Shirley, Michael Ashikhmin, and Steve Marschner, "Fundamentals of ComputerGraphics" ,A K Peters/CRC Press; 4th Edition, 2016.

Online Resources:

Sr. No.	Website Name
1.	www.nptel.ac.in
2.	www.coursera.org
3.	https://nptel.ac.in/courses/121/106/121106013/#
4.	http://msl.cs.uiuc.edu/vr/
5.	http://lavalle.pl/vr/

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDO7023	Quantum Computing	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITDO7023	Quantum Computing	20	30	50	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To know the fundamentals of Quantum computing and its applications.
2	To understand the efficient quantum algorithms for several basic promise problems.
3	To gain knowledge about quantum computers and their principles.
4	To understand the principles, quantum information and limitation of quantum operations formalizing.
5	To gain knowledge about different quantum error and its correction techniques.
6	To gain knowledge about different quantum cryptographic algorithms.

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	Basics of Quantum computing and its applications.	L1,L2
2	Solve various problems using quantum algorithms.	L1,L2
3	Methodology for quantum computers and their principles.	L1,L2,L3
4	Comprehend quantum noise and operations.	L1,L2,L3
5	Gain knowledge about different quantum error correction techniques.	L1,L2,L3
6	To gain knowledge about different quantum cryptographic algorithms.	L1,L2,L3

Prerequisite: NA

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Fundamentals Quantum Computing	Fundamental Concepts: Introduction and Overview – GlobalPerspectives – Quantum Bits – Quantum Computation – Quantum Algorithms – Experimental Quantum Information Processing – Quantum Information. Problems on Qubits **Self-learning Topics:** Detail of Quantum computing and its applications https://www.ibm.com/quantum-computing/what-is-quantum-computing/	**07**	**CO1**
II	QUANTUM COMPUTATION	Quantum Circuits – Quantum algorithms, Single Orbit operations, Control Operations, Measurement, Universal Quantum Gates, Simulation of Quantum Systems, Quantum Fourier transform, Phase estimation, Applications, Quantum search algorithms – Quantum counting – Speeding up the solution of NP – complete problems – Quantum Search for an unstructured database. Problems on Boolean functions and Quantum gates, Quantum gates and circuits. **Self-learning Topics:** Application of Quantum Computing	**08**	CO2
III	Quantum Computers	Guiding Principles, Conditions for Quantum Computation, Harmonic Oscillator Quantum Computer, Optical Photon Quantum Computer – Optical cavity Quantum electrodynamics, Ion traps, Nuclear Magnetic resonance. **Self-learning Topics:** Qiskit	**06**	CO3
IV	Quantum Information	Quantum noise and Quantum Operations – Classical Noise and Markov Processes, Quantum Operations, Examples of Quantum noise and Quantum Operations – Applications of Quantum operations, Limitations of the Quantum operations formalism, Distance Measures for Quantum information. Problems on Measurement **Self-learning Topics:** Case study on Quantum noise andoperations.	**07**	CO4
V	QUANTUM ERROR CORRECTION	Introduction, Shor code, Theory of Quantum Error –Correction, Constructing Quantum Codes, Stabilizer codes, Fault – Tolerant Quantum Computation. Self-learning Topics: Case study on Quantum error correction.	**05**	CO5
VI	QUANTUM CRYPTOGRAPHY	Quantum Cryptography-Private Key Cryptography, Privacy Amplification and Information Reconciliation, Quantum Key	06	CO6

		Distribution, Privacy and Coherent Information, The Security of Quantum Key Distribution. Problems on Quantum error correction and cryptography. **Self-learning Topics:** Attacks on Quantum Cryptography		

Text Books:

1. Chris Bernhardt," Quantum Computing for Everyone", (The MIT Press) Hardcover – Illustrate ,September 2020,
2. Willi-Hans Steeb; "Problems and Solutions in Quantum Computing and Quantum Information", Yorick HardyAcademic Consulting and Editorial Services (ACES) Private Limited, January 2020.
3. M.A. Nielsen and I.Chuang,"Quantum Computation and Quantum Information", Cambridge University Press 2010.

References Books:

1. Computer Science: An Introduction by N. DavidMermin 5. Yanofsky's and Mannucci, Quantum Computing forComputer Scientists.
2. Parag K. Lala ,Quantum Computing: A Beginner's Introduction Paperback" , McGraw Hill November 2020.
3. V. Sahni, "Quantum Computing", Tata McGraw-Hill Publishing company,2007.
4. Nayak, Chetan; Simon, Steven; Stern, Ady; Das Sarma, Sankar, "NonabelianAnyons and Quantum Computation",2008.

Online References:
1. https://www.cousera.org
2. https://nptel.ac.in

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO7024	Information Retrieval System	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITDO7024	Information Retrieval System	20	30	50	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To learn the fundamentals of the information retrieval system.
2	To classify various Information retrieval models.
3	To demonstrate the query processing techniques and operations.
4	To compare the relevance of query languages for text and multimedia data.
5	To evaluate the significance of various indexing and searching techniques for information retrieval.
6	To develop an effective user interface for information retrieval.

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	Define and describe the objectives of the basic concepts of the Informationretrieval system.	L1,L2
2	Evaluate the taxonomy of different information retrieval models.	L1,L2,L3,L4
3	Try to solve and process text and multimedia retrieval queries and their operations.	L1,L2
4	Evaluate text processing techniques and operations in the information retrieval system.	L1,L2,L3,L4
5	Demonstrate and evaluate various indexing and searching techniques.	L1,L2,L3,L4
6	Design the user interface for an information retrieval system.	L1,L2,L3,L4

Prerequisite: Data Structures

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	**Indexing and searching Algorithms**	**02**	
I	Introduction	Motivation, Basic Concepts, The Retrieval Process, Information System: Components, parts and types on information system; Definition and objectives on information retrieval system, Information versus Data Retrieval. Search Engines and browsers **Self-learning Topics:** Search Engines , Search API	**06**	CO1
II	IR Models	Modeling: Taxonomy of Information Retrieval Models, Retrieval: Formal Characteristics of IR models, Classic Information Retrieval, Alternative Set Theoretic models, Probabilistic Models, Structured text retrieval Models, models for Browsing; **Self-learning Topics:** Terrier	**06**	CO2
III	Query Processing and Operations	Query Languages: Keyword based Querying, Pattern Matching, Structural Queries, Query Protocols; Query Operations: User relevance feedback, Multimedia IR models: Data Modeling **Self-learning Topics:** Proximity Queries and Wildcard Queries	**06**	CO3
IV	Text Processing	Text and Multimedia languages and properties: Metadata, Markup Languages, Multimedia; Text Operations: Document Preprocessing, Document Clustering. **Self-learning Topics:** Digital Library : Greenstone	**06**	CO4
V	Indexing and Searching	Inverted files, Other indices for text, Boolean Queries, Sequential Searching, Pattern Matching, Structural Queries, Compression; Multimedia IR: Indexing and Searching:- A Generic Multimedia indexing approach, , Automatic Feature extraction; Searching Web: Challenges, Characterizing the web, Search Engines. Browsing, Meta searches, Searching using Hyperlinks. **Self-learning Topics:** Koha	**07**	CO5
VI	User interface and visualization	Human Computer interaction, the information access process, starting points, query specifications, context, using relevance judgments, interface support for the search process. **Self-learning Topics:** SeeSoft	**06**	CO6

Text Books:

1. Modern Information Retrieval, Ricardo Baeza-Yates,berthier Ribeiro- Neto, ACM Press-Addison Wesley
2. Information Retrieval Systems: Theory and Implementation, Gerald Kowaski, Kluwer Academic Publisher
3. Storage Network Management and Retrieval by Dr. Vaishali Khairnar, Nilima Dongre, Wiley India.

References Books:

1. Introduction to Information Retrieval By Christopher D. Manning and Prabhakar Raghavan, Cambridge UniversityPress.
2. Information Storage & Retrieval By Robert Korfhage – John Wiley & Sons
3. Introduction to Modern Information Retrieval. G.G. Chowdhury. NealSchuman.

Online References:

1. https://www.geeksforgeeks.org/what-is-information-retrieval/
2. https://nlp.stanford.edu/IR-book/
3. https://en.wikipedia.org/wiki/Information_retrieval
4. https://people.ischool.berkeley.edu/~hearst/irbook/10/node1.html

Course Code	Course Name	Credits
ILO7011	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 anddeveloping 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 feasibilitystudy 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, machiningand 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 andimplementation, 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 Engineeringand Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Propertiesand 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 andimportance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05

04	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	**Integration of Environmental Aspects in Product Design:**Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for 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 CycleApproach, General Framework for LCCA, Evolution of Models for Product Life Cycle, Cost Analysis	05

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", TataMcGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Credits
ILO7012	**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; ConditionalProbability, 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, QualityAssurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time ToFailure (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, Unitredundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, SuccessPath 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

REFERENCES:

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

Course Code	Course Name	Credits
ILO7013	**Management Information System**	**03**

Course 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 varioustechnology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needsof the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Course Outcomes: Learner will be able to...

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improvebusiness performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they providevalue 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 andData Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysisand 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

REFERENCES:

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

Course Code	Course Name	Credits
ILO7014	**Design of Experiments**	**03**

Course Objectives:

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

Course Outcomes: Learner will be able to...

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

Module	Detailed Contents	Hrs
01	**Introduction** Strategy of Experimentation Typical Applications of Experimental DesignGuidelines for Designing Experiments Response Surface Methodology	06
02	**Fitting Regression Models** Linear Regression Models Estimation of the Parameters in Linear Regression ModelsHypothesis Testing in Multiple Regression Confidence Intervals in Multiple RegressionPrediction 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 General2^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 DesignResolution III
	Designs
	Resolution IV and V Designs
	Fractional Factorial Split-Plot
	Designs
		07

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

REFERENCES:

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

Course Code	Course Name	Credits
ILO7015	**Operations Research**	**03**

Course Objectives:

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

Course Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimalsolution 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 importantperformance 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-servermodels, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	Simulation: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	Dynamic programming. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	Game Theory. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	Inventory Models: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", JohnWilley 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
ILO7016	Cyber Security and Laws	03

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

Course Outcomes: Learner will be able to...

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

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world,Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, 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 CyberLaw	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the ITAct, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances:** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

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

Course Code	Course Name	Credits
ILO7017	**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 afterdisaster

Outcomes: Learner will be able to...

1. Get to know natural as well as manmade disaster and their extent and possible effects on theeconomy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structureassociated 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 : Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long termeffects 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 entireprocess.	06

04	Institutional Framework for Disaster Management in India: Importance of public awareness, Preparation and execution of emergency management programme.Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities importance of effective communication amongst different agencies in such situations. Use of Internet and softwares for effective disaste management. Applications of GIS, Remote sensing and GPS in this regard.	06
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

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 byCentre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth HeinemannElseveir 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
ILO7018	**Energy Audit and Management**	**03**

Objectives:

1. To understand the importance energy security for sustainable development and thefundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations tofacilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energysaving 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 identifythe energy saving opportunities.
4. To describe the energy performance evaluation ofsome common thermal installations and identifythe energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy savingmeasures

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features.Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI),Internal rate of return (IRR)	08

03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITC801	Blockchain and DLT	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITC801	Blockchainand DLT	20	30	50	100

Course Objectives:

Sr. No.	Course Objectives
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.

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	Describe the basic concept of Blockchain and Distributed Ledger Technology.	L1,L2
2	Interpret the knowledge of the Bitcoin network, nodes, keys, wallets and transactions	L1,L2,L3
3	Implement smart contracts in Ethereum using different development frameworks.	L1,L2,L3
4	Develop applications in permissioned Hyperledger Fabric network.	L1,L2,L3
5	Interpret different Crypto assets and Crypto currencies	L1,L2,L3
6	Analyze the use of Blockchain with AI, IoT and Cyber Security using case studies.	L1,L2,L3,L4

Prerequisite: Cryptography and Distributed Systems.

Detailed Syllabus

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Cryptography and Distributed Systems (prerequisite)	Hash functions, Public – Private keys, SHA, ECC, Digital signatures, Fundamental concepts of Distributed systems	02	—-
I	Introduction to DLT and Blockchain	Introduction to Blockchain: Technical definition of Blockchain. Elements of a blockchain Features of Blockchain Type of Blockchain, What is DLT . DLT V/S Blockchain CAP theorem Byzantine Generals Problem Consensus Mechanism and its Type Cryptographic primitives and data structure used in blockchain **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	04	CO1
II	Bitcoin	What is Bitcoin and the history of Bitcoin, Bitcoin Transactions, Bitcoin Concepts: keys, addresses and wallets, Bitcoin Transactions, UTXO. validation of transactions, Bitcoin Keys , Addresses, ECC , Base58 , BIP-38 , Pay-to Script and Multisig Addresses, Vanity Addresses , Concept of Wallet, Wallet Technologies in Bitcoin HD wallet from Seed. Transaction Scripts and Scripts address, Bitcoin Mining and Difficulty levels Structure of Blocks and Blockheader and Genesis Block , linking of Block. **Bitcoin Network**: Bitcoin Core node and API, 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 Bitcoin Testnet Basics of Bitcoin Forensics: Analysis of Address and Wallet , Clustering of Addresses following Money **Self-learning Topics:** Study and compare different consensus algorithms like PoA, PoS, pBFT	08	CO2
III	Permissionless Blockchain: Ethereum	Introduction to Ethereum, Ethereum 1.0 and 2.0 , Turing completeness EVM and compare with bitcoin	**10**	CO3

		Basics of Ether Units, Ethereum Wallets Working with Metamask EOA and Contracts Transaction:: Structure of Transaction, Transaction Nonce, Transaction GAS, Recipient, Values and Data, Transmitting Values to EOA and Contracts **Smart Contracts and Solidity** Development environment and client , Basic of Solidity and Web 3 Life cycle of Smart contract, Smart Contract programming using solidity, Metamask (Ethereum Wallet), Setting up development environment, Use cases ofSmart Contract, Smart Contracts: Opportunities and Risk. **Smart Contract Deployment**: Introduction to Truffle, Use of Remix and test networks for deployment **Self-learning Topics:** Smart contract development usingJava or Python		
IV	Permissioned Blockchain: Hyperledger Fabric	Introduction to Framework, Tools and Architecture of Hyperledger Fabric Blockchain. **Components**: Certificate Authority, Nodes, Chain codes, Channels, Consensus: Solo, Kafka, RAFT Designing Hyperledger Blockchain Other Challenges : Interoperability and Scalability of blockchain **Self-learning Topics:** Fundamentals of Hyperledger Composer	**07**	CO4
V	Crypto assets and Cryptocurrencies	ERC20 and ERC721 Tokens, comparison between ERC20 & ERC721, NFT, ICO, STO, Different Crypto currencies **Self-learning Topics:** Defi, Metaverse, Types of cryptocurrencies	**04**	CO5
VI	Blockchain Applications & casestudies	Blockchain in IoT, AI, Cyber Security **Self-learning Topics:** Applications of Blockchain in various domains Education, Energy, Healthcare, real-estate, logistics, supply chain	**04**	CO6

Text Books:

1. "Mastering Bitcoin, PROGRAMMING THE OPEN BLOCKCHAIN", 2nd Edition by Andreas M. Antonopoulos, June2017, 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, AshwaniKumar, 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.

References:

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/

Course Code	Course Name	Teaching Scheme (ContactHours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
ITL801	Blockchain Lab	--	2	--	--	1	--	01

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITL801	Blockchain Lab	25	--	25	50

Lab Objectives:

Sr.No	Lab Objectives
1	To develop and deploy smart contracts on local Blockchain.
2	To deploy the smart contract on test networks.
3	To deploy and publish smart contracts on Ethereum test network.
4	To design and develop crypto currency.
5	To deploy chain code on permissioned Blockchain.
6	To design and develop a Full-fledged DApp using Ethereum/Hyperledger.

Lab Outcomes:

Sr.No	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
1	Develop and test smart contract on local Blockchain.	L3,L4
2	Develop and test smart contract on Ethereum test networks.	L3,L4
3	Write and deploy smart contract using Remix IDE and Metamask.	L4
4	Design and develop Cryptocurrency.	L4
5	Write and deploy chain code in Hyperledger Fabric.	L4
6	Develop and test a Full-fledged DApp using Ethereum/Hyperledger.	L5

Prerequisite: Programming Langauges.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Java, Python, JavaScript	02	—
I	Local Blockchain	Introduction to Truffle, establishing local Blockchainusing Truffle Mini Project: Allocation of the groups	02	LO1
II	Smart contracts and chaincode	Solidity programming language, chain code (Java/JavaScript/Go), deployment on Truffle local Blockchain Mini Project: Topic selection	04	LO2
III	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 Mini Project: Topic validation and finalizing software requirements	04	LO3
IV	Remix IDE and Metamask	Smart contract development and deployment using Metamask and Remix Design and develop Crypto currency Mini Project: Study the required programming language for smart contract	04	LO4
V	Chain code deployment in Hyperledger Fabric	Chain code deployment in Hyperledger fabric Mini project: Study required front end tools	04	LO5
VI	Mini-project on Design and Development of a DApps using Ethereum/ Hyperledger Fabric	Implementation of Mini Project 1. Design, configure and testing of mini project Report submission as per guidelines	06	LO6

Mini project:

1. Students should carry out mini-project in a group of three/four students with a subject In-charge
2. The group should meet with the concerned faculty during laboratory hours and the progress of work discussed must bedocumented.
3. Each group should perform a detailed literature survey and formulate a problem statement.
4. Each group will identify the hardware and software requirement for their defined mini project problem statement.
5. Design, develop and test their smart contract/chain code.
6. Each group may present their work in various project competitions and paper presentations

Documentation of the Mini Project

The Mini Project Report can be made on following lines:

1. Abstract
2. Contents
3. List of figures and tables
4. Chapter-1 (Introduction, Literature survey, Problem definition, Objectives, Proposed Solution, Technology/platform used)
5. Chapter-2 (System design/Block diagram, Flow chart, Software requirements, cost estimation)
6. Chapter-3 (Implementation snapshots/figures with explanation, code, future directions)
7. Chapter-4 (Conclusion)
8. References

Text Books:

1. Ethereum Smart Contract Development, Mayukh Mukhopadhyay, Packt publication.
2. Solidity Programming Essentials: A Beginner's Guide to Build Smart Contracts for Ethereum and Blockchain, Ritesh Modi,Packt publication.
3. Hands-on Smart Contract Development with Hyperledger Fabric V2, Matt Zand, Xun Wu and Mark Anthony Morris,O'Reilly.

References Books:

1. Mastering Blockchain, Imran Bashir, Packt Publishing
2. Introducing Ethereum and Solidity, Chris Dannen, APress.
3. Hands-on Blockchain with Hyperledger, Nitin Gaur, Packt Publishing.

Online References:

1. https://trufflesuite.com/
2. https://metamask.io/
3. https://remix.ethereum.org/
4. https://www.hyperledger.org/use/fabric

Course Code	Course Name	Teaching Scheme (ContactHours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
ITL802	Cloud Computing	--	2	--	--	1	--	01

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITL802	Cloud Computing	20	30	50	100

Lab Objectives:

Sr.No	Lab Objectives
1	To make students familiar with key concepts of virtualization.
2	To make students familiar with various deployment models of cloud such as private, public,hybrid andcommunity.
3	To understand the using and adopting appropriate type of cloud for their application.
4	To make students familiar with various service models such as IaaS, SaaS, PaaS, Security as a Service (SECaaS) and Database as a Service.
5	Apply the different service models for the application.
6	To make students familiar with security and privacy issues in cloud computing and how to address them.

Lab Outcomes:

Sr.No	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
1	Implement different types of virtualization techniques.	L1,LL3,L4
2	Analyze various cloud computing service models and implement them to solvethe given problems.	L1,L2,L3,L4
3	Design and develop real world web applications and deploy them on commercialcloud(s).	L6
4	Explain major security issues in the cloud and mechanisms to address them.	L1,L2,L3
5	Explore various commercially available cloud services and recommend the appropriate one for the given application.	L1,L2,L3
6	Implement the concept of containerization.	L1,L2,L3

Prerequisite: Programming Langauges, DBMS.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	DBMS, Programming Language.	02	—
I	Overview & Virtualization	Introduction and overview of cloudcomputing. Hosted Virtualization using KVM. Lab1: To study and implement Hosted VirtualizationusingVirtual Box & KVM. Lab2: To study and Implement Bare-metal Virtualization using Xen, HyperV or VMware Esxi.	04	LO1
II	Infrastructure Services.	To study the infrastructure services using differentcloud platform Lab3: To study and Implement Infrastructure as a Service usingAWS/Microsoft Azure/Google cloudplatform	04	LO2
III	Platform Services	To study the different platform services. Lab4: To study and Implement Platform as a Service using AWS Elastic Beanstalk/ Microsoft Azure AppService.	03	LO3
IV	Cloud Services	IaaS, PaaS, STaaS, DbaaS, IAM andSecurity as a Service on AWS and Azure. Lab5: To study and Implement Security as a Service onAWS/Azure. Lab6: To study and implement Identity and Access Management (IAM) practices on AWS/Azure cloud.	04	LO4
V	Storage Services	To study the storage services using Docker. Lab7: To study and Implement Storage as a Service using Own Cloud/ AWS S3, Glaciers/ Azure Storage. Lab8: To study and Implement Database as a Service on SQL/NOSQL databases like AWS RDS, AZURE SQL/MongoDB Lab/ Firebase. Lab9: To study and Implement Containerization using Docker on AWS/Azure/Google cloud platform.	04	LO5
VI	Kubermetes	Introduction and overview of Kubernetes. Lab10: To study and implement container orchestration using Kubernetes on AWS/Azure/Google cloud platform	05	LO6

Textbooks:

1	Bernard Golden, "Amazon Web Services for Dummies", John Wiley & Sons, Inc.
2	Michael Collier, Robin Shahan, "Fundamentals of Azure, Microsoft Azure Essentials",Microsoft Press.
3	RajkumarBuyya, Christian Vecchiola, S ThamaraiSelvi, "Mastering Cloud Computing",Tata McGraw-Hill Education.
4	Barrie Sosinsky, "Cloud Computing Bible", Wiley publishing.
5	John Paul Mueller, "AWS for Admins for Developers", John Wiley & Sons, Inc.
6	Ken Cochrane, Jeeva S. Chelladhurai, NeependraKhare , "Docker Cookbook - SecondEdition", Packt publication
7	Jonathan Baier, "Getting Started with Kubernetes-Second Edition", Packt Publication.

Online References:

1. https://phoenixnap.com/kb/ubuntu-install- kvm\
2. NIST Cloud Computing Security Reference Architecture
3. https://docs.citrix.com/en-us/xenserver/7- 1/install.html
4. https://docs.aws.amazon.com
5. https://docs.microsoft.com/en-us/azure
6. https://docs.docker.com/get-started/
7. https://kubernetes.io/docs/home/

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITM701	Major Project – II	--	12	--	--	06	--	06

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITM701	Major Project – II	25	--	25	50

Course Objectives
1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcome: Learner will be able to...
1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Major Project
- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or morethan four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini projectin 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 weeklyactivity of major project-I and major project-II.

- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor canverify and record notes/comments.
- Faculty supervisor may give inputs to students during major project -I & II activity; however, focus shall be onself-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possiblesolution in consultation with guide/ supervisor
- Students shall convert the best solution into working model using various components of their domain areas anddemonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of Universityof Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Major Project, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Major Project-I in semester VII and Major Project-II in semesters VIII.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Major Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to Scopus paper publications in Journal/Conference or Copyright or Patent as anextension of the Major Project-1 with suitable improvements/modifications after testing and analysis in even semester. This policy can be adopted on case by case basis.

Review/progress monitoring committee may consider following points for assessment based on either one year major project as mentioned in general guidelines.
One-year project:

1. In semester VII entire theoretical solution shall be ready, including components/system selection and cost analysis, building of working prototype. Two reviews will be conducted based on presentation given by students group.
2. First shall be for finalization of problem and proposed solution of the problem
3. Second shall be on readiness of working and testing of prototype to be conducted.
4. In semester VIII expected work shall be procurement of testing and validation of results based on work completed in an odd semester.
5. First review is based on improvements in testing and validation results cum demonstration for publication to be conducted.
6. Second review shall be based on paper presentation in conference/journal or motivate for copyright or Indian patent in last month of the said semester.

Assessment criteria of Major Project.

Major Project shall be assessed based on following criteria;

- Quality of survey/ need identification
- Clarity of Problem definition based on need.
- Innovativeness in solutions
- Feasibility of proposed problem solutions and selection of best solution
- Cost effectiveness
- Societal impact

- Innovativeness
- Cost effectiveness and Societal impact
- Full functioning of working model as per stated requirements
- Effective use of skill sets
- Effective use of standard engineering norms
- Contribution of an individual's as member or leader
- Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may beused for second semester evaluation of performance of students in mini project.

Guidelines for Assessment of Major Project Practical/Oral Examination:
- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Major Project shall be assessed through a presentation and demonstration of working model by the student projectgroup to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Scopus Conferences/Journals or copy right or Indian Patent.

Major Project shall be assessed based on following points;
1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication
9. Publications in Sem VIII.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO8011	Big Data Analytics	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITDO8011	Big Data Analytics	20	30	50	100

Course Objectives:

Sr.No	Course Objectives
1	To provide an overview of an exciting growing field of Big Data analytics.
2	To discuss the challenges traditional data mining algorithms face when analyzing Big Data.
3	To introduce the tools required to manage and analyze big data like Hadoop, NoSql MapReduce.
4	To teach the fundamental techniques and principles in achieving big data analytics with scalability andstreaming capability.
5	To introduce to the students several types of big data like social media, web graphs and data streams.
6	To enable students to have skills that will help them to solve complex real-world problems in decision support.

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	Explain the motivation for big data systems and identify the main sources of Big Datain the real world.	L1,L2,L3
2	Demonstrate an ability to use frameworks like Hadoop, NOSQL to efficiently store,retrieve and process Big Data for Analytics.	L1,L2,L3
3	Implement several Data Intensive tasks using the Map Reduce Paradigm.	L1,L2,L3
4	Apply several newer algorithms for Clustering Classifying and finding associations in Big Data.	L1,L2,L3
5	Design algorithms to analyze Big data like streams, Web Graphs and Social Media data.	L6
6	Design and implement successful Recommendation engines for enterprises.	L6

Prerequisite: AI and DS

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Data Mining, Data Science	02	
I	Introduction toBig Data	Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, Big Data Challenges, Examples of Big Data in Real Life, Big Data Applications **Self-learning Topics:** Identification of Big Data applicationsand its solutions	03	CO1
II	Introduction to Big Data Frameworks	What is Hadoop? Core Hadoop Components; Hadoop Ecosystem; Working with Apache Spark What is NoSQL? NoSQL data architecture patterns: Key- value stores, Graph stores, Column family (Bigtable) stores,Document stores, MongoDB **Self-learning Topics:** HDFS vs GFS, MongoDB vs other NoSQL system, Implementation of Apache Spark	06	CO2
III	MapReduce Paradigm	MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures. Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce , Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce, Computing Natural Join by MapReduce, Grouping and Aggregation by MapReduce, Matrix Multiplication, Matrix Multiplication with One MapReduce Step . Illustrating use of MapReduce with use of real life databases and applications. **Self-learning Topics:** Implementation of MapReduce algorithms like Word count, Matrix-Vector and Matrix-Matrix algorithm	07	CO3
IV	Mining Big Data Streams	The Stream Data Model: A DataStream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing. Sampling Data in a Stream : Sampling Techniques. Filtering Streams: The Bloom Filter Counting Distinct Elements in a Stream : The Count-Distinct Problem, The Flajolet-Martin Algorithm, Combining Estimates, Space Requirements . Counting Ones in a Window: The Cost of Exact Counts, The Datar-Gionis-Indyk, Motwani Algorithm, Query Answering in the DGIM Algorithm. **Self-learning Topics:** Streaming services like Apache Kafka/Amazon Kinesis/Google Cloud DataFlow. Standard spark streaming library. Integration with IOT devices to capture real time	07	CO4

		stream data.		
V	Big Data Mining Algorithms	Frequent Pattern Mining : Handling Larger Datasets in MainMemory Basic Algorithm of Park, Chen, and Yu. The SON Algorithm and MapReduce. Clustering Algorithms: CURE Algorithm. Canopy Clustering, Clustering with MapReduce Classification Algorithms: Overview SVM classifiers, Parallel SVM, KNearest Neighbor classifications for Big Data, One Nearest Neighbour. **Self-learning Topics:** Standard libraries included with sparklike graphX, MLlib	07	CO5
VI	Big Data Analytics Applications	**Link Analysis :** PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: PageRank Iteration Using MapReduce, Topic sensitive Page Rank, link Spam, Hubs and Authorities, HITS Algorithm. **Mining Social- Network Graphs :** Social Networks as Graphs, Types , Clustering of Social Network Graphs, Direct Discovery of Communities, Counting triangles using Map-Reduce. **Recommendation Engines:** A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering **Self-learning Topics:** Sample applications like social media feeds, multiplayer game interactions, retail industry, financial data analysis. Use case like location data, real-time stock trades, log monitoring etc	07	CO6

Text Books:

1. Anand Rajaraman and Jeff Ullman "Mining of Massive Datasets", Cambridge University Press.
2. Alex Holmes "Hadoop in Practice", Manning Press, Dreamtech Press.
3. Professional NoSQL Paperback, by Shashank Tiwari, Dreamtech Press
4. Rajkumar Buyya, ,Rodrigo N. Calheiros and Amir Vahid Dastjerdi, "Big Data Principles and Paradigms", Morgan Kaufmann

References Books:

1. Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, Bart Baesens , WILEY Big DataSeries.
2. Big Data Analytics with R and Hadoop by Vignesh Prajapati Paperback, Packt Publishing Limited
3. Hadoop: The Definitive Guide by Tom White, O'Reilly Publications

Online References:
1. https://nptel.ac.in/courses/106/104/106104189/
2. https://nptel.ac.in/courses/106106142/
3. https://nptel.ac.in/courses/106105186/

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITDO8012	Reinforcement Learning	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITDO8012	Reinforcement Learning	20	30	50	100

Course Objectives:

Sr.No	Course Objectives
1	Define the key features of reinforcement learning that distinguishes it from AI and non-interactive machine learning.
2	Introduce to statistical learning techniques where an agent explicitly takes actions and interacts with the world.
3	Implement in code common RL algorithms.
4	Describe multiple criteria for analyzing RL algorithms & evaluate algorithms on these metrics: e.g. regret,sample complexity, computational complexity, empirical performance, convergence, etc.
5	Know how to implement dynamic programming as an efficient solution approach to an industrial controlproblem.
6	Explore solutions to the Exploration-Exploitation Dilemma.

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	Learn how to define RL tasks and the core principles behind the RL, including policies,value functions, deriving Bellman equations.	L1,L2
2	Evaluate work with tabular methods to solve classical control problems.	L1,L2,L3
3	Apply Markov Decision Processes to solve real-world problems.	L1,L2,L3
4	Understand the dynamic programming for policy Evaluation.	L1,L2
5	Implement reinforcement learning problems based on averaging sample returns usingMonte Carlo method.	L1,L2,L3
6	Recognize current advanced techniques and applications in RL.	L1,L2,L3

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Probability distributions and expected values, and basic linear algebra (e.g., inner products).	02	
I	Introduction	**Reinforcement Learning**: Key features and Elements of RL, Types of RL, rewards. **Reinforcement Learning Algorithms**: Q-Learning, State Action Reward State Action (SARSA) **Self-learning Topics:** Deep Q Neural Network (DQN), Applications of RL	04	CO1
II	Bandit	An n-Armed Bandit Problem, Action-Value MethodsTracking a Nonstationary Problem, Optimistic Initial Values Upper-Confidence-Bound Action Selection Gradient Bandits **Self-learning Topics:** Associative Search (Contextual Bandits)	07	CO2
III	Markov Decision Processes:	The Agent–Environment Interface, Goals and Rewards, Returns, Markov properties, Markov Decision Process, Value Functions and Optimal Value Functions, **Self-learning Topics:** Optimality and Approximation	07	
IV	Dynamic Programming:	Policy Evaluation (Prediction), Policy Improvement, Policy Iteration, Value Iteration, Asynchronous Dynamic Programming, Generalized Policy Iteration **Self-learning Topics:**	07	CO4
V	Monte Carlo Methods and Temporal-Difference Learning	Monte Carlo Prediction, Monte Carlo Estimation of ActionValues, Monte Carlo Control, TD Prediction, TD control using Q-Learning **Self-learning Topics:** Off -policy Prediction via Importance Sampling	07	CO5
VI	Applications and Case Studies	Elevator Dispatching, Dynamic Channel Allocation, Job-ShopScheduling **Self-learning Topics:** Study of applications.	05	CO6

Text Books:

1. Reinforcement Learning: An Introduction, by Richard S. Sutton and Andrew G. Barto
2. Alessandro Palmas, Dr. Alexandra Galina Petre, Emanuele Ghelfi, The Reinforcement Learning Workshop: Learn how toApply Cutting-edge Reinforcement Learning Algorithms to a Wide Range of Control Problems, 2020 Packt publishing.
3. Phil Winder, Reinforcement Learning Industrial Applications with Intelligent Agents, O'Reilly
4. Dr Engr S M Farrukh Akhtar, Practical Reinforcement Learning, Packt Publishing, 2017.

References Books:

1. Maxim Lapan, Deep Reinforcement Learning Hands-On: Apply modern RL methods, with deep Q-networks, valueiteration, policy gradients, TRPO, AlphaGo Zero.
2. Csaba Szepesv´ari, Algorithms for Reinforcement Learning, Morgan & Claypool Publishers
3. Alberto Leon-Garcia, Probability, Statistics and Random Processes for Electrical Engineering, Third Edition, PearsonEducation, Inc.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO8013	Simulation and Modeling	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITDO8013	Simulation and Modeling	20	30	50	100

Course Objectives:

Sr.No	Course Objectives
1	To introduce the discrete event simulation systems.
2	To discuss the modeling techniques of entities, queues, resources and entity transfers in the discrete event environment.
3	To formulate and apply the statistical models in simulation and queuing theory.
4	To gain knowledge of random numbers, random variates and various statistical tests on random numbers.
5	To formulate and build valid models and perform simulation analysis of the system and analyze resultsproperly.
6	To familiarize with various applications of Simulation.

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 meaning of simulation and Identify the common applications ofdiscrete-event system simulation.	L1,L2
2	Practice formulation and modeling skills.	L1,L2,L3
3	Analyze events and inter-arrival time, arrival process, queuing strategies, resources anddisposal of entities using statistical models.	L1,L2,L3,L4
4	Understand pseudo-random numbers and perform statistical tests to measure the qualityof pseudo-random numbers.	L1,L2
5	Apply different distributions to fit the collected data and describe the process ofverification and validation of simulation models.	L1,L2,L3
6	Describe various applications of simulation.	L1,L2

Prerequisite: Probability and Statistics

Detailed Syllabus

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Concepts of Probability: Probability mass function, Probability density function, Mean, Variance, Median, Mode	**02**	-
I	Introduction toSimulation	Simulation Definition, When Simulation is an appropriate tool and when it is not, Advantages and disadvantages of simulation, Areas of application of simulation, System and its types, Models and its types, Steps in simulation study **Self-learning Topics:** Monte Carlo simulation	**04**	CO1
II	Simulation Examples and General Principles	Simulation Process, Simulation of Single-server and multi-server queueing systems, Simulation of(M, N) Inventory and Newspaper Seller Problem, Simulation of Lead-time Demand Concepts in Discrete Event Simulation, Event Scheduling Algorithm, Manual Simulation of Single Server and Dump Truck Problem using Event Scheduling Algorithm **Self-learning Topics:** Simulation of Reliability Problem, Process Interaction Approach in Simulation.	**08**	CO2
III	Mathematical ,Statistical and Queueing Models inSimulation	Statistical Models: Terminology and concepts, Useful statistical models, Discrete Distributions (Bernoulli's trial, Binomial and Negative Binomial, Poisson Distributions), Continuous Distributions (Exponential, Uniform, Erlang, Triangular and Normal Distributions), PoissonProcess, Queueing Models: Queuing Notations, Long Run Performance Measures, M/M/1 and M/G/1 Queueing Systems **Self-learning Topics:**	**08**	CO3
IV	Random Numbersand Variates	Random Number Generation: Why are random numbers required in simulation? Properties of random numbers, Linear Congruential Method to generate Random Numbers, Test for Uniformity: Kolmogorov-Smirnov, Chi-Square, Test for Independence: Runs up and runs down, Runs above and below mean, Poker test), Random Variate Generation: Inverse Transform Technique, Direct Transformation for Normal and Lognormal distribution, Acceptance Rejection Technique **Self-learning Topics:** Tests for Autocorrelation	**08**	CO4

V	Analysis of Simulation Data	Steps in Input Modeling, Goodness-of-fit tests, Selecting Input Model without data, Multivariate and Time Series Models, Model Building verification and validation, Verification of simulation models, Naylor and Finger Approach for calibration and Validation of simulation models **Self-learning Topics:** Input-Output Validation: Using Historical Input Data	**06**	CO5
VI	Applications ofSimulation	High-Level Computer-System Simulation and Memory Simulation, Simulation of Manufacturing and Material Handling Systems **Self-learning Topics:** Simulation of Computer networks	**03**	CO6

Text Books:
1. J. Banks, J. S. Carson, B. L. Nelson and D. M. Nicol (2001), Discrete Event System Simulation, 3rd Ed., Prentice-Hall.
2. J. Banks, J. S. Carson, B. L. Nelson and D. M. Nicol (2001), Discrete Event System Simulation, 4th Ed., Prentice-Hall.

References Books:

1. A. M. Law and W. D. Kelton (2000), Simulation Modeling and Analysis, 4th Ed., McGraw Hill.
2. K. S. Trivedi (2001), Probability and Statistics with Reliability, Queuing and Computer Science Applications, Eastern Economy Edition, Prentice-Hall (India).
3. Banks C M, Sokolowski J A, Principles of Modeling and Simulation, Wiley
4. Geoffrey Gordon, System Simulation, EEE
5. Narsing Deo, System Simulation with Digital Computer; PHI

Online References:

1. https://www.udemy.com/course/discrete-event-system-simulation/
2. https://www.tutorialspoint.com/modelling_and_simulation/index.htm

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDO8014	Knowledge Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITDO8014	Knowledge Management	20	30	50	100

Course Objectives:

Sr.No	Course Objectives
1	Establish a foundation of key terms and concepts, historical events and contributions, organizational benefits,and guiding principles on which to build greater understanding of knowledge management.
2	Appreciate the role and use of knowledge for individuals, as well as organizations and institutions.
3	Increase information and understanding about knowledge transfer using low- and high technology strategies.
4	Explore the future of knowledge management and its influence on our jobs, communities, and society.
5	Explore different tools for knowledge codification and knowledge transfer.
6	Discuss impact of knowledge management on product, people and organization, etc. with qualitative andquantitative measures.

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	Discuss KM, learning organizations, intellectual capital and related terminologies in clear terms and understand the role of knowledge management in organizations.	L1,L2,L3
2	Demonstrate an understanding of the history, concepts, and the antecedents of management of knowledge and describe several successful knowledge management systems.	L1,L2,L3
3	Evaluate the impact of technology including telecommunications, networks, and Internet/intranet role in managing knowledge.	L4,L5
4	Discuss new jobs, roles and responsibilities resulting from the New or Knowledge Economy Ponder KM's current and future impact on individuals, organizations and society at large.	L1,L2,L3
5	Apply different tools for knowledge transfer and Business Intelligence in knowledge sharing.	L1,L2,L3

6		Analyze different modes of knowledge conversion and testing tools for knowledge codification.		L1,L2,L3,L4

Prerequisite: An introductory course in IT/ IS

Detailed Syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Meaning of data, information, knowledge and expertise Meaning of epistemology, Types of Knowledge -Subjective & Objective views of knowledge, procedural Vs. declarative, tacit Vs. explicit, general Vs. specific.	02	
I	Introduction to Knowledge Management	What is Knowledge? Data, information and knowledge, Knowledge management process, Types of expertise – associational, motor skill, theoretical Characteristics of knowledge – explicitness, codifiability, teachability, specificity, Reservoirs of knowledge, Meaning of Knowledge Management, Forces Driving Organizational issues in KM, KM Systems & their role, Relevance of KM in today's dynamic & complex environment, Future of Knowledge Management **Self-Learning Topics:** Study the various KM process.	07	CO1
II	Knowledge management system life cycle	Challenges in Building KM Systems – Conventional versus KM System Life Cycle (KMSLS) – Knowledge Creation and Knowledge Architecture – Nonaka's Model of Knowledge Creation and Transformation, Knowledge Architecture. **Self-Learning Topics:** Case study for KMSLS.	06	CO2
III	KM Solutions for capture, sharing & applications	KM Processes, KM Systems, Mechanisms & Technologies, Knowledge Capturing Techniques: Brain Storming – Protocol Analysis – Consensus Decision Making – Repertory Grid-Concept Mapping –Blackboarding, Nominal Group Technique, Delphimethod. **Self-Learning Topics:** Study various technologiesused in KM in industry.	06	CO5
IV	Knowledge codification	Modes of Knowledge Conversion – Codification Tools and Procedures – Knowledge Developer's Skill Sets – System Testing and Deployment – Knowledge Testing –Approaches to Logical Testing, User Acceptance Testing – KM System Deployment Issues – User Training – Post implementation. **Self-Learning Topics:** Study different tools for testingfor KM.	06	CO6

V	Knowledge transfer and sharing	Transfer Methods – Role of the Internet – Knowledge Transfer in e-world – KM System Tools – Neural Network – Association Rules – Classification Trees –Data Mining and Business Intelligence – Decision Making Architecture – Data Management – Knowledge Management Protocols – Managing Knowledge Workers. **Self-Learning Topics:** Case study for transfer methods in KM.	06	CO3
VI	KM Impact	Dimensions of KM Impact – People, Processes, Products & Organizational Performance Factors influencing impact – universalistic & contingency views Assessment of KM Impact – Qualitative & quantitative measures, Identification of appropriate KM solutions, Competing with Business Analytics,	06	CO4

Text Books:

1. Irma Becerra-Fernandez, Avelino Gonzalez, Rajiv Sabherwal (2004). Knowledge Management Challenges, Solutions, andTechnologies. Prentice Hall. ISBN: 0-13-109931-0.
2. Elias M. Awad, Hassan M. Ghaziri (2004). Knowledge Management. Prentice Hall. ISBN: 0-13-034820-1
3. Donald Hislop, Knowledge Management in Organizations, Oxford 2nd Edition. Ian Watson (2002).
4. Shelda Debowski, Knowledge Management, Wiley India Edition
5. Keri E Pearlson, Carol S. Saunders, Strategic Management of Information System, Wiley India Edition
6.

References Books:

1. Madanmohan Rao (2004). Knowledge Management Tools and Techniques: Practitioners and Experts Evaluate KM Solutions. Butterworth-Heinemann. ISBN: 0750678186.
2. Stuart Barnes (Ed.) (2002). Knowledge Management Systems Theory and Practice. Thomson Learning.
3. Kimiz Dalkir, Knowledge Management in Theory and Practice, Elsevier, Butterworth Hinemann.
4. Applying Knowledge Management: Techniques for Building Corporate Memories. Morgan Kaufmann. ISBN:1558607609.

Online resources:

1. https://onlinecourses.nptel.ac.in/noc19_mg33/preview
2. https://www.udemy.com/course/knowledge-management/
3. https://www.coursehero.com/file/70272191/km-pdf-imppdf/
4. http://cs.unibo.it/~gaspari/www/teaching/slides_KM6.pdf

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDO8021	User Interface Design	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITDO8021	User InterfaceDesign	20	30	50	100

Course Objectives:

Sr.No	Course Objectives
1	To stress the importance of good interface design.
2	To understand the importance of human psychology as well as social and emotional aspect in designing good interfaces.
3	To learn the techniques of data gathering, establishing requirements, analysis and data interpretation.
4	To learn the techniques for prototyping and evaluating user experiences.
5	To understand interaction design process and evaluate design.
6	To bring out the creativity in each student – build innovative applications that are usable, effective and efficient for intended users.

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	Identify and criticize bad features of interface designs.	L1,L2,L3
2	Predict good features of interface designs.	L1,L2,L3
3	Illustrate and analyze user needs and formulate user design specifications.	L1,L2,L3
4	Interpret and evaluate the data collected during the process.	L1,L2,L3
5	Evaluate designs based on theoretical frameworks and methodological approaches.	L1,L2,L3,L4,L5
6	Apply better techniques to improve the user interaction design interfaces.	L1,L2,L3

Prerequisite: Software Engineering.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Software Engineering concepts and any programming Language **Self-learning Topics:** Web design languages	**02**	NA
I	Introduction to Interaction Design	Good and Poor Design, What is Interaction Design, The User Experience, The Process Of Interaction Design, Interaction Design and the User Experience, Necessity of UI/UX **Self-learning Topics:** Study of Various interactive day to day application	**05**	CO1
II	Understanding and Conceptualizing Interaction Cognitive aspects and Social, Emotional Interaction	Understanding the Problem Space and Conceptualizing Design, Conceptual Model, Interface Types, Cognitive aspects, Social Interaction and the Emerging Social Phenomena, Emotions and the User Experience, Expressive and Frustrating Interfaces, Persuasive Technologies **Self-learning Topics:** Study of Various interactive Interface Types	**05**	CO2
III	Data Gathering, Establishing Requirements, Analysis, Interpretation and Presentation	Establishing Requirements, Five Key Issues, Techniques for Data Gathering, Data Analysis Interpretation and Presentation, Task Description and Task Analysis **Self-learning Topics:** Any case study of how to gather requirements .(eq.BE Project)	**08**	CO3
IV	Process of Interaction Design, Prototyping, Construction.	Interaction Design Process, Prototyping and Conceptual Design, Interface Metaphors and Analogies **Self-learning Topics:** Study of two websites with usability concepts.	**07**	CO4 / CO5
V	Design rules and Industry standards	Design principles, Principles to support Usability, Standards and Guidelines, Golden rules and Heuristics, ISO/IEC standards .The 15 Rules Every UI/UX Designer Should Know . **Self-learning Topics:** Study experiments on industry standards and design principles. principles.https://xd.adobe.com/ideas/career-tips/15-rules-every-ux-designer-know/	**07**	CO5

VI	Evaluation Techniques and Framework	The Why, What, Where and When of Evaluation, Types of Evaluation, case studies, DECIDE Framework, Usability Testing, conducting experiments, Field studies, Heuristic Evaluation and walkthroughs, Predictive models. **Self-learning Topics:** Evaluation of any GUI with usability principles.	**05**	CO5/CO6

Text Books:

1. Interaction Design, by J. Preece, Y. Rogers and H. Sharp. ISBN 0-471-49278-7.
2. Human Computer Interaction, by Alan Dix, Janet Finlay, Gregory D Abowd, Russell Beale
3. Alan Cooper, Robert Reimann, David Cronin, "About Face3: Essentials of Interaction design",Wiley publication.
4. Wilbert O. Galitz, "The Essential Guide to User Interface Design", Wiley publication.

References Books:

1. The UX Book, by Rex Hartson and Pardha S Pyla
2 .Donald A. Norman, "The design of everyday things", Basic books.
3. Jeff Johnson, "Designing with the mind in mind", Morgan Kaufmann Publication.
4. UI Design: Key to captivate User Understanding, by Nilakshi Jain, Dhananjay Kalbande

Online References:

1. https://onlinecourses.nptel.ac.in/noc21_ar05/preview

2. https://nptel.ac.in/courses/124/107/124107008/

3. https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ar10/

4. https://nptel.ac.in/courses/107/103/107103083/

5. https://www.youtube.com/watch?v=6C2Ye1makdY&list=PLW-zSkCnZ-gD5TDfs1eL5EnH2mQ0f9g6B

6. https://xd.adobe.com/ideas/process/

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO8022	Robotics	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITDO8022	Robotics	20	30	50	100

Course Objectives:

Sr. No.	Course Objectives
1	Learn the basic concepts of Robot.
2	Learn the concepts of Kinematics of Robotics.
3	Learn the different types of Actuators and Sensors in Robot Designing.
4	Learn the concepts of Motions, Velocities and Dynamic Analysis of Force.
5	Learn the concepts of Trajectory and Motion Planning.
6	Learn the different Programming Languages to program Robot.

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 different types of robot, its characteristics and applications.	L1,L2
2	Analyse kinematics parameters of robotic manipulator.	L1,L2,L3,L4
3	Identify actuators, sensors and control of a robot for different applications.	L1,L2,L3
4	Apply the differential relationships of motion, velocities and dynamic analysis of force.	L1,L2,L3
5	Apply the concept of trajectory and motion planning in robot programming.	L1,L2,L3
6	Use robot programming languages and acquire skills to program robots.	L1,L2,L3

Prerequisite: Mathematical concepts of Geometry, Linear Algebra, Calculus, Basic Electronics

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Homogenous Coordinate System, Matrix Representation and its Operations, Vector Algebra: Dot and Cross Products, Orthogonal and Orthonormal Vectors	**02**	--
I	Introduction and Fundamentals of Robotics	Automation and its types, definition of Robotics and a Robot, History of Robotics, Advantages and Disadvantages of Robot, Robotic Manipulators, Robot Motions, Robot Anatomy, Links and Joints, Classification of Robots, Specification of Robot, Applications of Robots **Self-learning Topics:** Robot Coordinate System, Economic and Social Aspects of Robotics	**04**	CO1
II	Direct and Inverse Kinematics	Homogeneous transformation matrices, Inverse transformation matrices, Forward and inverse kinematic equations for position and orientation, Denavit-Hartenberg Representation of Forward Kinematic Equations of Robots, The Inverse Kinematic Solution of Robots, Case Studies: Three Axes Planar Articulated Robot Arm (Mini-Drafter) and Four Axes Adept-1 SCARA robot **Self-learning Topics:** Study of Five Axes Rhino XR- Robot Arm and Six Axes Articulated Intelledex 660 Robot Arm	**08**	CO2
III	Actuators and Sensors	Characteristics of Actuating Systems, Comparison of Actuating Systems, Hydraulic Devices, Pneumatic Devices, Electric Motors, Magnetostrictive Actuators, Sensor Characteristics, Position Sensors, Velocity Sensors, Acceleration Sensors, Force and Pressure Sensors, Torque Sensors, Light and Infrared Sensors, Touch and Tactile Sensors, Proximity Sensors, Sniff Sensors, Vision Systems, Voice Synthesizer **Self-learning Topics:** Microprocessor Control of Electric Motors, Microswitches, Range Finders, Voice Recognition Devices	**06**	CO3
IV	Motions, velocities and dynamic analysis of force	Differential relationship, Jacobian, Differential motions of a frame and robot, Inverse Jacobian, Lagrangian, mechanics,Moments of Inertia, Dynamic equations of robots, Transformation of forces and moment between coordinate frames **Self-learning Topics:** Static Force Analysis of Robots	**08**	CO4

V	Trajectory and Motion Planning	Trajectory planning, Joint-space trajectory planning, Cartesian-space trajectories, Concept of motion planning, Bug Algorithms – Bug1, Bug2, Tangent Bug **Self-learning Topics:** Case Study based on real life application of motion planning (eg. Chess Game, Robotic Race, etc.)	**05**	CO5
VI	Introduction to Robot Programming	Definition of Robot Program, Robot Programming Techniques like Online programming, Lead- through programming, Walk-through programming, Offline programming, Task programming, Motion Programming, Robotic Programming Language: Overview, Requirements for Standard Robot Language, Introduction to Robot Languages like AL, AML, RAIL, RPL, VAL, etc. **Self-learning Topics:** Example of Robot Programusing VAL.	**06**	CO6

Text Books:

1. Robert Shilling, "Fundamentals of Robotics-Analysis and control", PHI, 2003.
2. Saeed B. Niku, "Introduction to Robotics Analysis, Systems, Applications",3rd Edition, Wiley, 2019.
3. Saha, S.K., "Introduction to Robotics", 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.
4. Ashitava Ghoshal, "Robotics-Fundamental Concepts and Analysis", Oxford University Press, Sixth impression, 2010
5. Mukherjee S., "Robotics Process Automation", 1st Edition, Khanna Publishing House, New Delhi, 2020.

References Books:

1. John J. Craig, "Introduction to Robotics – Mechanics & Control", 3rd Edition, Pearson Education, India, 2009
2. Mark W. Spong & M. Vidyasagar, "Robot Dynamics & Control", 2nd Wiley India Pvt. Ltd., 2004
3. Aaron Martinez & Enrique Fernandez, "Learning ROS for Robotics Programming", 1st Edition, Shroff Publishers, 2013
4. Howie Choset, Kevin M. Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia E. Kavraki and Sebastian Thrun, "Principles of Robot Motion –Theory, Algorithms and Implementations", Prentice-Hall of India, 2005
5. Fu, Gonzalez, Lee, "Robotics: Control, Sensing, Vision and Intelligence", 1st Edition, Mc Graw Hill, India.

Online References:

1. https://swayam.gov.in/nc_details/NPTEL
2. https://www.udemy.com/course/robotics-course/
3. https://www.coursera.org/courses?query=robotics

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO8023	ERP	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITDO8023	ERP	20	30	50	100

Course Objectives:

Sr. No.	Course Objectives
1	To learn the basic concepts of ERP.
2	To learn different technologies used in ERP.
3	To learn the concepts of ERP Manufacturing Perspective and ERP Modules.
4	To learn what are the benefits of ERP.
5	To study and understand the ERP life cycle.
6	To learn the different tools used in ERP.

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 basic concepts of ERP.	L1,L2
2	Identify different technologies used in ERP.	L1,L2,L3
3	Understand and apply the concepts of ERP Manufacturing Perspective and ERP Modules.	L1,L2
4	Discuss the benefits of ERP.	L1,L2,L3
5	Understand and implement the ERP life cycle.	L1,L2
6	Apply different tools used in ERP.	L1,L2,L3

Prerequisite: Basics of software**.**

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basics of software.	**02**	--

I	Introduction toERP	Enterprise – An Overview Integrated Management Information, Business Modeling, Integrated Data Model **Self-Learning Topics:** Study of advantages ofERP.	**04**	CO1
II	ERP Technologies	Business Processing Reengineering(BPR), Data Warehousing, Data Mining, On-line Analytical Processing(OLAP), Supply Chain Management(SCM), Customer RelationshipManagement(CRM), MIS - Management Information System, DSS - Decision Support System, EIS - Executive Information System **Self-Learning Topics:** Study different ERP technologies.	**06**	CO2
III	ERP Manufacturing Perspective andERP Modules	MRP - Material Requirement Planning, BOM - Bill Of Material, MRP - Manufacturing Resource Planning, DRP – Distributed Requirement Planning, PDM - Product Data Management. Finance, Plant Maintenance, Quality Management,Materials Management. **Self-Learning Topics:** Study different ERP modules.	**08**	CO3
IV	Benefits of ERP	Reduction of Lead-Time, On-time Shipment, Reduction in Cycle Time, Improved Resource Utilization, Better Customer Satisfaction, Improved Supplier Performance, Increased Flexibility, Reduced Quality, Costs, Improved Information Accuracy and Design-making Capability. **Self-Learning Topics:** Study of benefits of ERPfor real time application.	**08**	CO4
V	ERP Life cycle	Pre-evaluation Screening, Package Evaluation,Project Planning Phase, Gap Analysis, Reengineering, Configuration, Implementation Team Training, Testing, Going Live, End-user Training, Post-implementation (Maintenance mode). **Self-Learning Topics:** ERP testing tools.	**05**	CO5
VI	E-Commerce to E-business	E-Business structural transformation, Flexible Business Design, Customer Experience, Create the new techo enterprise, New generation e-business leaders, memo to CEO, Empower your customer, Integrate Sales and Service, Integrated Enterprise applications. Enterprise resource planning the E-business Backbone Enterprise architecture, planning, ERP usage in Real world, ERPImplementation. **Self-Learning Topics:** ERP Applications.	**06**	CO6

Text Books:

1. Enterprise Resource Planning - Alexis Leon, Tata McGraw Hill.
2. Enterprise Resource Planning – Diversified by Alexis Leon, TMH.
3. Enterprise Resource Planning - Ravi Shankar & S. Jaiswal , Galgotia.

References Books:

1. Guide to Planning ERP Application, Annetta Clewwto and Dane Franklin, McGRaw-Hill, 1997
2. The SAP R/3 Handbook, Jose Antonio, McGraw – Hill
3. E-Business Network Resource planning using SAP R/3 Baan and Peoplesoft : A Practical Roadmap For Success By Dr. RaviKalakota

Online References:

1. https://www.udemy.com/
2. https://www.sap.com/
3. www.oracle.com

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDO8024	Cloud Computing and Services	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
ITDO8024	Cloud Computing and Services	20	30	50	100

Course Objectives:

Sr.No	Course Objectives
1	Understand and analyze the basics of cloud computing, service models, deployment models and architecture.
2	Define and understand the concept of virtualization and related technologies.
3	Understand the different cloud computing services and their relevance's.
4	Describe the various services provided by Amazon Web Services cloud platform.
5	Understand and analyze the functionality of Openstack cloud platform & Severless computing.
6	Describe the aspects of Security & Privacy in cloud computing.

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	Explain the basics concepts of cloud computing like service models, deployment models and its architecture.	L1,L2,L3
2	Describe and apply virtualization in cloud computing.	L1,L2,L3
3	Use and Analyze different cloud computing services.	L1,L2,L3,L4
4	Understand and apply various services provided by Amazon Web Services cloudplatform.	L1,L2,L3
5	Discuss the functionality of Openstack cloud platform & Severless computing.	L1,L2,L3
6	Recognize and examine the security and privacy concerns in cloud computing.	L1,L2,L3

Prerequisite: Computer Network, Operating System.

Detailed Syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Concepts of Computer Network, NetworkSecurity and Operating System.	02	
I	Introduction to cloudcomputing	Introduction to cloud computing, need for cloud computing and its components, cloud & other similar configurations, cloud types: NIST and Cloud Cube Model, characteristics of cloud computing, deployment models, service models, advantages and disadvantages of CloudComputing. **Self-learning Topics:** Study the recent trends in cloud computing architectures and related technologies.	06	CO 1
II	Virtualization	Characteristics of virtualized environment, structures of virtualization, implementation levels of virtualization, mechanisms of virtualization, pros and cons of virtualization, virtualization vs cloud computing, Xen and KVM architecture. **Self-learning Topics:** Comparison between different virtualization platforms.	06	CO 2
III	Cloud Computing Services	SPI Model of Cloud computing, Everything as a Service (XaaS): Database as a Service, Storage as a Service, Security as a Service, Collaboration as a Service, Monitoring as a Service, Network as a Service, Disaster Recovery as a service, Identity management as a Service, Analytics as a Service and Backup as a Service. **Self-learning Topics:** Study of different cloud computing platforms providing XaaS services.	04	CO 3
IV	Amazon Web Service Cloud Platform	Introduction to the AWS Cloud, AWS core services by categories.Compute Service: Introduction to EC2, EC2 Instances, EC2 Amazon Machine Images, Instance Types, Instance Lifecycle. Storage Service: Introducing S3, working with Buckets, setting bucket security, S3 event and notification, bucket properties, working with Elastic Block Store Volumes, Object Storage Vs Block Storage, Archives versus backups, Introduction to Glacier. Virtual Private Cloud: Introduction, Subnet, Elastic Network Interfaces, Internet Gateways, Route Tables, Security Groups. CloudWatch: Introduction, CloudWatch	09	CO 4

		Metrics, CloudWatch Alarms. Database as a Service: Introduction to Amazon Relational Database Service (RDS), Database Engines, Database Instance Classes, Backup and Recovery, Non-relational (No-SQL) Databases, Types of Non relational Databases, Introduction to DynamoDB, Features, Partition and Hash Keys. **Self-learning Topics:** Comparison of AWS services with other cloudservice platforms like Azure and GCP.		
V	Openstack Cloud platform & Severless Computing	Open source Cloud Platform: Introduction to Openstack cloud platform, Components and modes of Operations, Architecture of Openstack cloud platform. Mobile Cloud Computing: Definition, architecture, benefits and challenges of mobile cloud computing. Serverless Computing: Introduction, Working with Serverless environment, Basics of severless events and functions, AWS Lambda. **Self-learning Topics:** To study different open source cloud computing platforms and compare them based on different XaaS services provided by them.	05	CO 5
VI	Cloud Security & Privacy	What is security, why is it required in cloud computing, Different types of security in cloud, attacks, and vulnerabilities, IaaS security, PaaS security, SaaS security, trust boundary, Audit andreporting. Introduction to Identity and access Management (IAM), IAM Challenges, IAM Definition, IAM Architecture and Practice, Relevant IAM Standards and Protocols for Cloud Services. Privacy: What Is Privacy? What Are the Key Privacy Concerns in the Cloud?, Legal and Regulatory Implications: Laws and Regulations, Governance, Risk, and Compliance (GRC). **Self-learning Topics:** To assess and analyze how the security and privacy is maintained in different cloudcomputing platforms.	07	CO 6

Text Books:

1. Cloud computing Bible, Barrie Sosinsky, Wiley publication.
2. Cloud Computing Black Book, Kailash Jayaswal, Jagannath Kallalurchi, Donald J. Houde, Dr. Deven

Shah, Dreamtech Press

3. Mastering Cloud Computing, Rajkumar Buyya, MGH publication
4. AWS certified solution Architect, Joe Baron et.al, Cybex publication
5. Cloud Security and Privacy, Tim Mather, Subra Kumaraswamy, and Shahed Latif, O'Reilly Publication.
6. Cloud security: A comprehensive guide to secure cloud computing by ronold L Krutz and Russell Dean Vines, Wiley publication.

Reference Books:

1. Distributed and Cloud Computing From Parallel Processing to the Internet of Things, Kai Hwang, Geoffrey C. Fox, JackDongarra, Morgan Kaufmann Publication
2. Cloud Computing for Dummies, Judith Hurwitz, Wiley Publication
3. Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, George Reese, O'Reilly Publication.
4. Cloud computing security: foundation and challenges, John R Vecca, CRC Press

Online References:

1. https://www.aws.amazon.com
2. https://www.nttel.ac.in

Course Code	Course Name	Credits
ILO8011	**Project Management**	**03**

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

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

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

05	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects.Team management, communication and project meetings. **Monitoring and Controlling Projects:**Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **Project Contracting** Project procurement management, contracting and outsourcing,	8
06	**Project Leadership and Ethics**: Introduction to project leadership, ethics in projects.Multicultural and virtual projects. **Closing the Project:**Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

REFERENCES:

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

Course Code	Course Name	Credits
ILO8012	**Finance Management**	**03**

Course Objectives:

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

Course Outcomes: Learner will be able to...

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

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09

04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches— Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

REFERENCES:

1.   Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F.Houston; Publisher: Cengage Publications, New Delhi.

2.   Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers:McGraw Hill Education, New Delhi.

3.   Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.

4.   Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) &Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO8013	**Enterpreneurship Development and Management**	**03**

Course Objectives:

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

Course Outcomes: Learner will be able to...

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

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDPcell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08

05	**Effective Management of Business:** Issues and problems faced by micro and smallenterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, fourtypes of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

REFERENCES:

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

Course Code	Course Name	Credits
ILO8014	**Human Resource Management**	**03**

Course Objectives:

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

Course Outcomes: Learner will be able to…

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

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing,Empowerment, TQM, Managing ethical issues.	5

02	**Organizational Behavior (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits forIncreasing Self Awareness • Perception: Attitude and Value, Effect of perception on IndividualDecision-making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performingteams, Team Roles, cross functional and self-directed team. • Case study	7
03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles& conflicts: Concept of roles; role dynamics; role conflicts and Stress • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	6
04	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	5
05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
06	**HR & MIS** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations**	10

| | Evolution of IR, IR issues in organizations, Overview of Labor Laws in India;Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act | |

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

Course Code	Course Name	Credits
ILO8015	**Professional Ethics and Corporat Social Responsibility (CSR)**	**03**

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

Course Outcomes: Learner will be able to…
1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand the legal aspects of corporate social responsibility

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

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

Course Code	Course Name	Credits
ILO8016	**Research Methodology**	**03**

Course Objectives:

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

Course Outcomes: Learner will be able to...

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

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology, Need of Research in Business and Social Sciences Objectives of Research Issues and Problems in Research Characteristics of Research:Systematic, Valid, Verifiable, Empirical and Critical	09
02	**Types of Research** Basic Research Applied Research Descriptive Research Analytical Research Empirical Research Qualitative and Quantitative Approaches	07
03	**Research Design and Sample Design** Research Design – Meaning, Types and Significance, Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	07
04	**Research Methodology** 4.1 Meaning of Research Methodology 4.2. Stages in Scientific Research Process: Identification and Selection of Research Problem Formulation of Research Problem Review of Literature Formulation of Hypothesis Formulation of research Design Sample Design	08

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

REFERENCES:

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

Course Code	Course Name	Credits
ILO8017	**IPR and Patenting**	**03**

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

Course outcomes: Learners will be able to understand

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. Work for development, promotion, protection, compliance and enforcement of intellectual property and patenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:**Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:**Challenges for IP in digital economy, e-commerce, human genome,biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:**Definition of Patents, Conditions of patentability, Patentable and non- patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07

05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publicationetc, Time frame and cost, Patent Licensing, Patent Infringement	07
	Patent databases: Important websites, Searching international databases	

REFERENCE BOOKS:

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

Course Code	Course Name	Credits
ILO8018	**Digital Business Management**	**03**

Course Objectives:

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

Course Outcomes: The learner will be able to …..

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

Module	Detailed content	Hours
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services), Opportunities and Challenges in Digital Business	09
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumerbehavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business ECand Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e- commerce business, Launching a successful online business and EC project, Legal, Ethics andSocietal impacts of EC	06
3	**Digital Business Support services**: ERP as e –business backbone, knowledgeTope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06

4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

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

Course Code	Course Name	Credits
ILO8019	**Environmental Management**	**03**

Course Objectives:

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

Course Outcomes: Learner will be able to…

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

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

References:

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