Vivekanand Education Society's
Institute of Technology
(Autonomous Institute Affiliated to University of Mumbai, Approved by AICTE & Recognised by Govt. of Maharashtra)
NAAC accredited with 'A' grade

Department of Information Technology

Syllabus (NEP Scheme)

Semester -IV

w.e.f

A.Y. 2024-25

Semester IV								
Course Type	Course name	Teaching scheme (Contact Hours)			Credits assigned			Total
		Th	Pr	Tu	Th	Pr	Tut	
Programme Core Course (PCC)	OS	3	2	--	3	1	--	4
Programme Core Course (PCC)	Fundamentals of IOT	3	2	--	3	1	--	4
Programme Core Course (PCC)	Introduction to AI	2	--	--	2	--	--	2
Multidisciplinary Minor (MDM)	Containerization and Virtualization Techniques	3	2	--	3	1	--	4
Open Elective (OE) Other than a particular program O1	Open Elective	3	--	1	3	--	1	4
Vocational and Skill Enhancement Course (VSEC)	Web Development Lab	1	2	--	1	1	--	2
Ability Enhancement Course (AEC -01, AEC-02)	Field Project	--	2	--	--	2	--	2
Entrepreneurship/Economics/ Management Courses	Innovation and Entrepreneurship	--	--	2*	--	--	2*	2
Total Credits	contact hours	15	10	3				24

Semester IV								
Course Type	Course name	Teaching scheme (Contact Hours)			Credits assigned			Total
		Th	Pr	Tu	Th	Pr	Tut	
Programme Core Course (PCC) Marks = 150	OS	3	2	--	3	1	--	4
Programme Core Course (PCC) Marks = 150	Fundamentals of IOT	3	2	--	3	1	--	4
Programme Core Course (PCC) Marks = 100	Introduction to AI	2	--	--	2	--	--	2
Multidisciplinary Minor (MDM) Marks = 150	Containerization and Virtualization Techniques	3	2	--	3	1	--	4
Open Elective (OE) Other than a particular program O1 Marks = 100	Open Elective	3	--	1	3	--	1	4
Vocational and Skill Enhancement Course (VSEC) Marks = 25 + 25 = 50	Web Development Lab	1	2	--	1	1	--	2
Ability Enhancement Course (AEC -01, AEC-02) Marks = 25	Field Project	--	2	--	--	2	--	2
Entrepreneurship/Economics/ Management Courses Marks = 25	Innovation and Entrepreneurship	--	--	2*	--	--	2*	2
Marks = 725 +25=750	contact hours	15	10	3				24

Semester IV Examination Scheme									
Course Type	Course Code	Course Name	Theory				Term Work	Pract & oral	Total
			Internal Assessment		End Sem Exam	Exam Duration (in Hrs)			
			Mid Test	CA					
PCC	NITPC41	Operating System	20	20	60	2	25	25	150
PCC	NITPC42	Fundamentals of IOT	20	20	60	2	25	25	150
PCC	NITPC43	Introduction to AI	20	20	60	2	-	-	100
OE	NITOE4X	Open Elective	20	20	60	2	-	-	100
VSEC	NITVS41	Web Development Lab	-	-	-	-	25	25	50
MDM	NITMM41	Containerization and Virtualization Techniques	20	20	60	2	25	25	150
EM	NM41	Innovation and Entrepreneurship *	-	-	-	-	25	-	25
ELC	NITP41	Field Project	-	-	-	-	25	-	25
								TOTAL MARKS	750

COURSE NAME: OPERATING SYSTEM

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
NITPC41	OPERATING SYSTEM (Theory)	03	---	---	03	---	---	03
NITPCL41	OPERATING SYSTEM (Lab)	---	02	---	---	01	---	01

Operating System(Theory)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
NITPC41	OPERATING SYSTEM (Theory)	03	---	---	03	---	---	03

Examination Scheme							
Course Code	Course Name	Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NITPC41	OPERATING SYSTEM (Theory)	20	20	60	---	---	100

Course Prerequisite:	
Course Objectives:	
1	To understand the major components of the Operating System & its functions.
2	To introduce the concept of a process and its management like transition, scheduling, etc.
3	To understand basic concepts related to Inter-process Communication (IPC) like mutual exclusion, deadlock, etc. and role of an Operating System in IPC.
4	To understand the concepts and implementation of memory management policies and virtual memory.
5	To understand functions of Operating Systems for storage management and device management.
6	To study the advent of new emerging technologies.
Course Outcomes: After successful completion of the course students will be able to:	
1	Understand the basic concepts related to Operating Systems.
2	Describe the process management policies and illustrate scheduling of processes by CPU.
3	Explain and apply synchronization primitives and evaluate deadlock conditions as handled by the Operating System.
4	Describe and analyze the memory allocation and management functions of Operating Systems.
5	Analyze and evaluate the services provided by the Operating System for storage management.
6	Understand the advances in the new age Operating Systems.
Lab Outcomes:	
1	Identify the Unix general purpose commands
2	Apply Unix commands for system administrative tasks such as file system management and user management
3	Execute Unix commands for system administrative tasks such as process management and memory management

4	Implement basic shell scripts for different applications
5	Implement and analyze different process scheduling algorithms
6	Implement and analyze different memory management algorithms.

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut	Total
NITPCL41	**OPERATING SYSTEM (Lab)**	---	**02**	---	---	**01**	---	**01**

Examination Scheme							
Course Code	Course Name	Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NITPCL41	**OPERATING SYSTEM (Lab)**	**---**	**---**	**---**	**25**	**25**	**50**

Operating System(Theory)

Module	Contents	Hrs
Fundamentals of Operating System	Introduction to Operating Systems including Cloud-Based OS, Containerized OS, and Edge Computing OS. Historical perspective, types, functionalities, and their role in IT.	**04**
Process Management	Basic Concepts of Process; Process Attributes, Process States Process Control Block, Introduction to Schedulers. Process Scheduling algorithms (FCFS, SJF, RR, Priority),Convoy Effect, Thread management, Inter-process Communication, Race Condition, Critical Section Classical Synchronization Problems, Semaphores, Bankers Algorithm, Monitors, Locks. Deadlocks; Deadlock Detection and Recovery; Deadlock Prevention; Deadlock Avoidance.	**09**
Memory Management	Basic Concepts of Memory Management, Logical and Physical address map, Memory Allocation (Contiguous Memory allocation-Fixed and variable partition-Internal and External fragmentation, Paging, Segmentation, Page Replacement Algorithms(FIFO, LRU, MRU, Optimal), Considerations for cloud-based and containerized environments	**08**
File Systems	File system organization (FAT, NTFS, ext4), File Operations (open, read, write, close), Directory Structures (single-level, hierarchical), File System Implementation (inode, file allocation methods),File System Security and Permissions: User and group permissions, Access control lists (ACLs), Integration with Cloud Storage and Distributed File Systems.	**06**

Storage Management	Device drivers, I/O operations (polling, interrupts), interrupt handling, device allocation strategies (FCFS, SSTF, SCAN, CSCAN, LOOK, C-LOOK). Considerations for IoT and edge computing devices.	**06**
Advanced Topics in Operating Systems	Design principles of Cloud-Native Applications, Microservices Architecture, Serverless Computing, Infrastructure Automation, Security (Encryption, Identity Management), Resilience techniques (redundancy, fault tolerance), and Emerging trends (Edge computing, AI-driven operating systems, Quantum Computing).	**06**
	Total	**39**

Textbooks:	
1	A. Silberschatz, P. Galvin, G. Gagne, Operating System Concepts, 10th ed., Wiley, 2018
2	W. Stallings, Operating Systems: Internal and Design Principles, 9th ed., Pearson, 2018.
3	A. Tanenbaum, Modern Operating Systems, Pearson, 4th ed., 2015.
Reference Books:	
1	N. Chauhan, Principles of Operating Systems, 1st ed., Oxford University Press, 2014.
2	A. Tanenbaum and A. Woodhull, Operating System Design and Implementation, 3rd ed., Pearson
3	R. Arpaci-Dusseau and A. Arpaci-Dusseau, Operating Systems: Three Easy Pieces, CreateSpace Independent Publishing Platform, 1st ed., 2018.
Access to software and virtual labs:	
1	https://naim30.github.io/OS-virtual-lab/
2	https://vlabcomp.kjsieit.in/
3	https://hansalshah007.github.io/osvirtuallab/index.html
Industry articles and case studies :	

Internal Assessment:

1) Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2) Mid Term test is to be conducted when approx. 50% syllabus is completed.
3) Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	05 marks
8.	Multiple Choice Questions (Quiz)	05 marks
9.	Peer Review and participation the marks can be left blank (with discretion of faculty)	05 Marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

OPERATING SYSTEM(Lab)

Suggested Experiments: Students are required to complete at least 10 experiments.	
Star (*) marked experiments are compulsory.	
Sr. No.	**Name of the Experiment**
1*	a) Execution of Unix General Purpose Utility Commands like echo, clear, exit, date, time, uptime, cal, cat, tty, man, which, history, id, pwd, whoami, ping, ifconfig, pr, lp, lpr, lpstat, lpq, lprm, cancel, mail, etc. b) Working with Editor Vi/other editor.
2*	Execution of File System Management Commands like ls, cd, pwd, cat, mkdir, rmdir, rm, cp, mv, chmod, wc, piping and redirection, grep, tr, echo, sort, head, tail, diff, comm, less, more, file, type, wc, split, cmp, tar, find, vim, gzip, bzip2, unzip, locate, etc.
3*	Execution of User Management Commands like who, whoami, su, sudo, login, logout, exit, passwd, useradd/adduser, usermod, userdel, groupadd, groupmod, groupdel, gpasswd, chown, chage, chgrp, chfn, etc.
4	Execution of Process Management Commands like ps, pstree, nice, kill, pkill, killall, xkill, fg, bg, pgrep, renice, etc.
5*	Execution of Memory Management Commands like free, /proc/meminfo, top, htop, df, du, vmstat, demidecode, sar, pagesize, etc.
6*	• Write a shell script to perform arithmetic operations. • Write a shell script to calculate simple interest and Compound Interest calculation. • Write a shell script to determine largest among three integer numbers. • Write a shell script to determine if a given year is a leap year or not. • Write a shell script to determine Fahrenheit to Centigrade Conversion • Write a shell script to determine Area & Circumference of Circle

	• Write a shell script to search whether an element is present in the list or not. • Write a shell script to compare two strings. • Write a shell script for Employee Pay calculation • Write a Shell script to calculate Grade. • Write a shell script to implement a menu-driven calculator using a case statement. • Write a shell script to perform operations on directory like: display name of current directory; display list of directory contents; create another directory, write contents on that and copy it to a suitable location in your home directory; etc
7	• Write a Shell script for a Menu Driven program to check if entered number is • 1.Even or Odd 2.Prime 3.Palindrome 4.Armstrong • Write a shell script to search whether an element is present in the list or not. • Write a shell script to compare two strings. • Write a shell script to read and check if the directory / file exists or not, if not make the directory / file. • Write a shell script to perform operations on directory like: display name of current directory; display list of directory contents; create another directory, write contents on that and copy it to a suitable location in your home directory; etc.
8*	Execute the following scripts using grep / sed commands: • Write a script using grep command to find the number of words character, words and lines in a file. • Write a script using egrep command to display a list of specific types of files in the directory. • Write a script using sed command to replace all occurrences of a particular word in a given file. • Write a script using sed command to print duplicate lines in input.
9	Write a program to demonstrate any two CPU scheduling algorithms like FCFS, SJF, SRT, Round Robin, priority(preemptive or non preemptive) etc.
10	Write a program to implement dynamic partitioning placement algorithms i.e Best Fit, First-Fit, Worst-Fit etc.
11	Write a program to implement process synchronization using semaphore.
12	Implementing Various page replacement policies: FIFO, Optimal, LRU.

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term Work:	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

COURSE NAME: FUNDAMENTALS OF IOT

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
NITPC42	Fundamentals of IOT (Theory)	03	---	---	03	---	---	03
NITPCL42	Fundamentals of IOT(Lab)	---	02	---	---	01	---	01

Fundamentals of IOT (Theory)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
NITPC42	Fundamentals of IOT (Theory)	03	---	---	03	---	---	03

Examination Scheme							
Course Code	Course Name	Theory			Term Work	PR & OR	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NITPC42	Fundamentals of IOT (Theory)	20	20	60	---	---	100

Course Prerequisite:	
Course Objectives:	
1	To understand the basic building blocks of IoT
2	To understand various IoT components.
3	To understand the IoT Protocols.
4	To introduce data handling in IoT
5	To understand the Design Methodology in IoT through case studies.
6	To understand IoT systems through case studies.
Course Outcomes: After successful completion of the course students will be able to:	
1	Understand concepts, functional blocks and communication methodology relevant to IoT.
2	Identify various components of IoT
3	Compare various communication protocols for IoT
4	Understand various methods for data handling in IoT-based.
5	Design basic applications based on IoT using specific components.
6	Introduce various security issues in IoT
Learning Outcomes:	
1	Understand concepts, functional blocks and communication methodology relevant to IoT.
2	Identify various components of IoT
3	Compare various communication protocols for IoT
4	Understand various methods for data handling in IoT-based.
5	Design basic applications based on IoT using specific components.
6	Introduce various security issues in IoT

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut	Total
NITPCL42	Fundamentals of IOT (Lab)	---	02	---	---	01	---	01

Examination Scheme							
Course Code	Course Name	Theory			Term Work	PR & OR	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NITPCL42	Fundame-ntals of IOT (Lab)	---	---	---	25	25	50

Lab Prerequisite:	
Lab Objectives:	
1	To understand the concept of IoT device interfacing.
2	To learn the working of various IoT tools.
3	To understand different IoT Protocols
4	To learn various Cloud services for IoT.
Lab Outcomes: After successful completion of the course students will be able to:	
1	Interface various sensors to any IoT device and push data onto the cloud.
2	Remotely control various devices using Blynk App and Node-red environment.
3	Implement IoT protocols to control devices remotely.
4	Implement services like Google Assistance, Adafruit I/O, IFTTT, Firebase etc in IoT.

5	Configure AWS Cloud and its Application in IoT

FUNDAMENTALS OF IOT(Theory)

Module	Contents	Hrs
Introduction to IoT	Introduction to IoT Definition and Characteristics of IoT IoT Protocols IoT Functional Blocks IoT Communication Models IoT Communication APIs :- REST and WebSockets IoT Enabling Technologies Introduction to M2M and Difference between IoT and M2M	**07**
Components (Things) in IoT	Components (Things) in IoT Sensor Technology, Examples of Sensors Actuators Applications of RFID and WSN in IoT Exemplary Device:- R–Pi and its Interfaces, PCDuino, BeagleBone	**07**
Data Handling in IoT	Data Handling in IoT Data Acquiring and Storage, Organizing the Data, Transactions and Business Processes, Analytics Data Collection, Storage and Computing Using Cloud Platform, Introduction to Cloud Computing, Virtualization, Cloud Models, Cloud Services	**07**
Design Principles for Web Connectivity	Design Principles for Web Connectivity Communication Technologies – A comparison Web Communication Protocols for connected devices:- CoRE Environment, CoAP, LWM2M, MQTT, XMPP, HTTP, SOAP Protocols LPWAN Fundamentals: LORA and NBIoT	**07**

IoT Design Methodology	IOT Design Methodology: 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	**07**
IoT Case	Case Studies: Home Automation (Smart lighting, home intrusion detection), Cities (Smart Parking), Environment (Weather monitoring, weather reporting Bot. Students are expected to Work on mini project consisting of 2 sensors and 1 actuator	**03**
	Total	**39**

Textbooks:	
1	Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach, Universities Press.
2	Raj Kamal, " Internet of Things: Architecture and Design Principles", McGraw Hill Education ,First edition
3	David Hanes ,Gonzalo salgueiro"IoT Fundamentals Networking Technologies, Protocols and Use Cases for Internet of Things", Cisco Press, Kindle 2017 Edition
4	Andrew Minteer ,"Analytics for the Internet of Things(IoT)", Kindle Edition
Reference Books:	
1	Adrian McEwen, Hakim Cassimally, : Designing the Internet of Things", Paperback, First Edition.
2	Yashavant Kanetkar, Shrirang Korde: Paperback "21 Internet of Things (IOT) Experiments", BPB Publications.
Access to software and virtual labs:	
1	https://nptel.ac.in/courses/106105166
2	https://mqttlab.iotsim.io/readonly/
3	https://ifttt.com/

Industry articles and case studies :	
1	https://www.gsma.com/solutions-and-impact/technologies/internet-of-things/wp-content/uploads/2019/08/201902_GSMA_APAC_MobileIoT_Case_Study.pdf
2	https://iot.telenor.com/iot-case-studies/
3	https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9090208

Any other (Access to AI tools / Data driven insights (if applicable) or any other):	
	https://www.indevagroup.com/wp-content/uploads/2017/12/iot-case-studies-companies-leading-the-connected-economy-digital-report.pdf

Internal Assessment:

1) Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2) Mid Term test is to be conducted when approx. 50% syllabus is completed.
3) Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

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4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	05 marks

8.	Multiple Choice Questions (Quiz)	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

FUNDAMENTALS OF IOT (Lab)

Suggested Experiments: Students are required to complete at least 10 experiments.	
Star (*) marked experiments are compulsory.	
Sr. No.	**Name of the Experiment**
1*	Interfacing Various Sensors like LDR, ultrasonic, DHT etc (data collection) and pushing data on to Thingspeak Cloud
2*	Controlling IoT devices/sensors remotely using Node-red and Rpi.
3*	Application of MQTT in node red
4	Control a LED Remotely & Monitor Temperature values with a Raspberry Pi using Node-RED
5*	Controlling IoT devices using Blynk App.
6*	Temperature and Humidity monitor using Blynk
7	ESP8266 Voice Control With Google Assistant and Adafruit IO and IFTTT.
8*	Implementing Publish-Subscribe model using MQTT protocol and DHT11 sensor
9*	Google Firebase :- controlling LED using Android App
10	Publishing sensor data from ESP32 to AWS IoT Cloud.
11*	Device controlling over cloud on android mobile app :- Monitoring sensor and different data on mobile phone

12*	Creating an Emergency push button to upload status on Facebook
13*	To send Push notification to IoT device (R-Pi to Smart Phone)
14*	Google Assistant Controlled Switch Using NodeMCU
15	AWS and SNS service

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term Work:	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

COURSE NAME: Introduction to AI

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW /PR	Tut	Total
NITPC43	Introduction to AI	02	---	---	02	---	---	02

Examination Scheme							
Course Code	Course Name	Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NITPC43	Introduction to AI	20	20	60	---	---	100

Course Prerequisite: Basic knowledge of python programming.	
Course Objectives:	
1	Understand the basic principles and history of artificial intelligence.
2	Learn various problem-solving techniques used in artificial intelligence.
3	Gain knowledge of different methods for representing and reasoning with knowledge in AI systems.
4	Explore fundamental concepts and algorithms in machine learning.
5	Understand the ethical implications and societal impacts of AI technologies.
6	Develop practical skills through hands-on projects and exercises.
Course Outcomes: After successful completion of the course students will be able to:	

1	Define artificial intelligence and its subfields, describe its history and evolution, and discuss current and future prospects of AI technologies.
2	Demonstrate proficiency in applying problem-solving strategies such as search algorithms and heuristics to solve AI problems.
3	Understand and implement different methods of knowledge representation, including propositional and predicate logic, and use inference mechanisms for reasoning with knowledge.
4	Grasp fundamental concepts of machine learning, including types of learning (supervised, unsupervised, reinforcement), training, testing, and evaluation of machine learning models, and implement basic machine learning algorithms.
5	Critically analyze the ethical implications and societal impacts of AI technologies, including considerations related to employment, privacy, and social justice.
6	Develop practical skills through hands-on projects and exercises, applying AI techniques to solve real-world problems and reflecting on their ethical and societal implications.
Learning Outcomes:	
1	Define artificial intelligence and its subfields, describe its history and evolution, and discuss current and future prospects of AI technologies.
2	Demonstrate proficiency in applying problem-solving strategies such as search algorithms and heuristics to solve AI problems.
3	Understand and implement different methods of knowledge representation, including propositional and predicate logic, and use inference mechanisms for reasoning with knowledge.
4	Grasp fundamental concepts of machine learning, including types of learning (supervised, unsupervised, reinforcement), training, testing, and evaluation of machine learning models, and implement basic machine learning algorithms.
5	Critically analyze the ethical implications and societal impacts of AI technologies, including considerations related to employment, privacy, and social justice.

6	Develop practical skills through hands-on projects and exercises, applying AI techniques to solve real-world problems and reflecting on their ethical and societal implications.

Syllabus:

Module	Contents	Hrs
Introduction to Artificial Intelligence	• Introduction: Introduction to AI, AI techniques, Problem Formulation. • Intelligent Agents: Structure of Intelligent agents, Types of Agents, Agent Environments PEAS representation for an Agent.	**03**
Problem Solving in AI	• Problem-solving agents and environments • Uninformed search algorithms: breadth-first search,depth-first search,uniform-cost search,Iterative Deepening, Bidirectional search. • Informed search algorithms: Best First Search, A*, heuristic functions • Local Search algorithms:Hill Climbing, Simulated Annealing.	**06**
Knowledge Representation and Reasoning	• Propositional logic: syntax, semantics, satisfiability, entailment • First-order logic: syntax, semantics, inference rules, Forward and Backward Chaining, Resolution.	**05**
Machine Learning Fundamentals (Part 1)	**Introduction to Machine Learning:** • Overview of machine learning and its applications • Types of learning: supervised learning, unsupervised learning, reinforcement learning **Regression Analysis:** • Introduction to regression analysis, Linear regression, Polynomial regression.	**05**

	Classification Algorithms: ● Introduction to classification problems, Logistic regression, Decision trees, Overview of k-nearest neighbors algorithm, **Applications of Machine Learning : Regression and Classification Algorithms**	
Machine Learning Fundamentals (Part 2)	**Clustering Algorithms:** ● Introduction to clustering problems, K-means clustering, Hierarchical clustering. **Association Mining:** ● Introduction to association mining. ● Understanding frequent itemsets and association rule mining ● Exploring Apriori algorithm for association rule generation **Applications of Clustering and Association Mining**	**04**
Ethics and Societal Impacts of AI	● Ethical considerations in AI development: bias and fairness, privacy concerns, transparency and interpretability ● Societal impacts of AI: job displacement, economic inequality, social manipulation ● Autonomous systems and responsibility: autonomous vehicles, autonomous weapons, legal and ethical frameworks ● Ethical guidelines for AI research and deployment: principles for responsible AI, AI ethics committees, regulatory frameworks	**03**
	Total	**26**

Textbooks:	
1	Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig

2	Artificial Intelligence: Foundations of Computational Agents by David L. Poole and Alan K. Mackworth
3	Machine Learning: A Probabilistic Perspective by Kevin P. Murphy
4	Natural Language Processing with Python by Steven Bird, Ewan Klein, and Edward Loper
Reference Books:	
1	"Artificial Intelligence: Structures and Strategies for Complex Problem Solving" by George F. Luger
2	"Ethics for Artificial Intelligence" by Oliver Bendel.
3	George Lugar, AI-Structures and Strategies for Complex Problem Solving., 4/e, 2002, Pearson Education
4	Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication
5	
Access to software and virtual labs:	
1	https://developer.ibm.com/tutorials/
2	https://www.geeksforgeeks.org/real-life-applications-of-machine-learning/?ref=lbp
Industry articles and case studies :	
1	https://www.digitaleurope.org/news/case-studies-on-artificial-intelligence/
2	https://www.automate.org/ai/case-studies
3	https://www.automate.org/ai/case-studies
Any other (Access to AI tools / Data driven insights (if applicable) or any other):	
1	https://www.coursera.org/learn/machine-learning
2	https://www.coursera.org/learn/unsupervised-learning-recommenders-reinforcement-learning?specialization=machine-learning-introduction
3	https://builtin.com/machine-learning
4	https://intellipaat.com/blog/tutorial/data-science-tutorial/

Internal Assessment:

1) Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2) Mid Term test is to be conducted when approx. 50% syllabus is completed.
3) Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	05 marks
8.	Multiple Choice Questions (Quiz)	05 marks
9.	Peer Review and participation the marks can be left blank (with discretion of faculty)	05 Marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

COURSE NAME: Containerization and Virtualization Techniques

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
NITMM 41	**Containerization and Virtualization Techniques (Theory)**	**03**	**---**	**---**	**03**	**---**	**---**	**03**
NITMM 41	**Containerization and Virtualization Techniques (Lab)**	---	**02**	---	---	**01**	---	**01**

Containerization and Virtualization Techniques(Theory)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
NITMM41	Containerization and Virtualization Techniques (Theory)	03	---	---	03	---	---	03

Examination Scheme							
Course Code	Course Name	Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NITMM41	Containerization and Virtualization Techniques (Theory)	20	20	60	---	---	100

Course Prerequisite: Basic knowledge of cloud databases.	
Course Objectives:	
1	Define and understand the concept of virtualization and related technologies.
2	.To understand Hypervisors
3	To understand VMware virtualization using Vmware workstation
4	To understand Docker to build, ship and run containerized images.
5	To familiarize with the concept of Software Configuration Management.s.
Course Outcomes: After successful completion of the course students will be able to:	
1	Describe and apply virtualization in cloud computing..

2	Analyze Hypervisors and Export VM configurations and images for migration between hypervisors.
3	Analyze VMware virtualization using Vmware workstation and create virtual machines.
4	Analyze & Illustrate the Containerization of OS images and deployment of applications over Docker
5	Deploy and Examine the Software Configuration management using Ansible/Chef.
Learning Outcomes:	
1	Gain practical experience in setting up and managing virtual machines on both hosted and bare-metal hypervisors, such as VirtualBox, KVM, and XenServer.
2	Acquire knowledge of cloud architecture components and various cloud computing models, enabling understanding of cloud infrastructure design and deployment strategies.
3	Develop proficiency in Docker installation, image management, and container operations, allowing efficient deployment and management of containerized applications across different environments.
4	Acquire skills in writing Dockerfiles, building Docker images, and configuring containerized applications, facilitating streamlined deployment processes and improving application scalability.
5	Explore the capabilities of VMware Workstation for creating, managing, and accessing virtual machines, enabling efficient utilization of virtualization resources and enhancing productivity in virtualized environments.
6	Gain hands-on experience in creating virtual machines with custom specifications, including operating system selection, disk allocation, and memory configuration, ensuring proficiency in managing virtualized environments.

Containerization and Virtualization Techniques(Theory)

Module	Contents	Hrs
Virtualization	Characteristics of the Virtualized Environment,Structure of Virtualization, Implementation levels of Virtualization, Mechanisms of Virtualization, pros and cons of Virtualization, Virtualization vs Cloud Computing, storage, CPU, hardware and OS Virtualization, Xen and KVM architecture.	**07**

Hypervisors and VM portability	Introduction to Hypervisors: Type 1 (bare-metal) and Type 2 (hosted). Hypervisor functionality: Memory management, CPU scheduling, Device emulation, and Virtual networking. Import/export functionality: Exporting VM configurations and images for migration between hypervisors. Snapshotting: Creating point-in-time snapshots of VMs for backup and restore purposes.	**08**
Introduction to VMWare Simulator	Basics of VMWare, advantages of VMware virtualization, using Vmware workstation, Creating virtual machines-understanding virtual machines, creating a new virtual machine on the local host, cloning virtual machines, virtualizing a physical machine, starting and stopping a virtual machine.	**08**
Continuous Deployment: Containerization with Docker	Introduction to Docker Architecture and Container Life Cycle, understanding images and containers, Create and Implement Docker images using Docker file, Container Lifecycle and working with containers, To Build, deploy and manage web or software application on Docker Engine, Publishing image on Docker Hub.	**08**
Software Configuration Management	Introduction to Software Configuration Management, Introduction to Chef/Ansible, Installation, Environment, Roles, Commands, Puppet, Saltstack	**08**
	Total	**39**

Textbooks:	
1	David Marshall, Wade A. Reynolds, Advanced Server Virtualization: VMware and Microsoft Platform in the Virtual Data Center, Auerbach
2	Publications, 2006. Cloud Computing (Principles and Paradigms), Edited by Rajkumar Buyya, James Broberg, Andrzej Goscinski, John Wiley & Sons, Inc. 2011

3	Cloud computing a practical approach - Anthony T.Velte , Toby J. Velte Robert Elsenpeter,TATA McGraw- Hill , New Delhi – 2010
4	Russ McKendrick, Learn Ansible, Pakt Publication
5	Learning Chef: A Guide to Configuration Management and Automation by Mischa Taylor and Seth Vargo
6	Learning Nagios, Packt Publishing
Reference Books:	
1	https://www.softwaretestinghelp.com/integration-of-jenkins-with-selenium-webdriver/
2	https://docs.docker.com/get-started/
3	https://docs.ansible.com/ansible/latest/getting_started/index.html
4	https://learn.chef.io/
5	https://www.guru99.com/nagios-tutorial.html
Access to software and virtual labs:	
1	https://www.docker.com/
2	https://www.vmware.com/products/workstation-player.html
3	https://cloud.google.com/
Industry articles and case studies :	
1	AWS architecture center.
2	https://www.oracle.com/virtualization/virtualbox/
3	Docker documentation page.
Any other (Access to AI tools / Data driven insights (if applicable) or any other):	
1	https://xenserver.org/overview-xenserver.html
2	https://docs.docker.com/get-started/part2/
3	https://docs.vmware.com/en/VMware-Workstation-Pro/index.html

Internal Assessment:

1) Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2) Mid Term test is to be conducted when approx. 50% syllabus is completed.
3) Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	05 marks
8.	Multiple Choice Questions (Quiz)	05 marks
9.	Peer Review and participation the marks can be left blank (with discretion of faculty)	05 Marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut	Total
NITMML41	**Containerization and Virtualization Techniques (Lab)**	---	**02**	---	---	**01**	---	**01**

Examination Scheme							
Course Code	Course Name	Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NITMML41	**Containerization and Virtualization Techniques (Lab)**	---	---	---	**25**	**25**	**50**

Suggested Experiments: Students are required to complete at least 10 experiments.	
Star (*) marked experiments are compulsory.	
Sr. No.	**Name of the Experiment**
1*	Creating and running virtual machines on a Hosted Hypervisor like Virtual Box (Hosted Virtualization on Oracle Virtual Box Hypervisor)
2*	To study and implement Hosted Virtualization using KVM
3*	Creating and running virtual machines on Bare-Metal Hypervisor Xen Server
4	To study cloud architecture and cloud computing model
5*	To understand Docker Architecture and Container Life Cycle, install Docker and execute docker commands to manage images and interact with containers.
6*	To learn Dockerfile instructions, build an image for a sample web application using Dockerfile.

7	Explore the features and functionalities of VMware Workstation (e.g., creating, managing, and accessing virtual machines).
8*	Create a new virtual machine using VMware Workstation, specifying parameters such as operating system, disk size, and memory allocation.

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term Work:	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

Course Name: Sensors and Actuators (Theory)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
NOE41	Sensors and Actuators (Theory)	03	---	---	03	---	---	03

Sensors and Actuators

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NOE41	Sensors and Actuators (Theory)	---	–	01	---	–	01	01

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid Term Test	Continuous Assessment				
NOE41	Sensors and Actuators (Theory)	20	20	60	---	---	100

Course Prerequisite:

Course Objectives:	
1	To explain the measurement systems, errors of measurement.
2	To provide an understanding of the operation of sensors and transducers.
3	To familiarize the student with the Identification, classification, construction, working principle and application of various transducers used in Industry for Temperature, Pressure , Level & Flow measurement
4	To provide an understanding of the various types of actuation systems.
Course Outcomes: After successful completion of the course students will be able to:	
1	Explain the measurement systems, errors of measurement. List and compare various standards used for selection of transducers/sensors.
2	Describe the operation of sensors employed in Industrial applications.
3	Describe the working principles of Temperature transducers and Pressure sensors and their applications..
4	Explain the working of different transducers for Flow and Level measurement
5	Explain different actuating systems like Pneumatic and Hydraulic
6	Describe the working principle of various electrical actuators and compare Pneumatic, Hydraulic and electric actuators.

Sensors and Actuatory

Module		Content	Hrs
1		**Introduction to Measurement Systems**	6
	1.1	Introduction, Block diagram, Functional elements of measurement system, Static and Dynamic characteristics of transducers. Errors, Remedies for Errors.	
	1.2	Definition of Sensor & Transducer, classification, selection criteria, Need for sensors and Transducers.	
		Tutorial: 2	2
2		**Industrial Sensors**	6
	2.1	Principle,Construction and working of - resistive sensors, inductive sensors, capacitive sensors, piezoelectric sensors, encoders, tachometers and strain gauge	
	2.2	Panel and Industrial switches**:** Toggle, Push button, proximity, tactile,Temperature, Flow, Level and, Pressure Switch, Vibration switch	
		Tutorial : 2	2
3		**Temperature and Pressure Measurement**	**7**
	3.1	Definition and different Temperature scales.	
	3.2	Resistance Temperature Detector (RTD): Principle, types, configuration, construction ,working and characteristics of RTD	
	3.3	Thermocouple: Principle, thermo electric effect, See-beck effect, Peltier effect, Laws of thermocouple, types of thermocouples with	

		Tutorial : 3	3
4		**Flow and Level Measurement**	**7**
	4.1	Introduction to fluid flow: types of fluid, continuity equation. Bernoulli's equation, hydrostatic law, Pascal's law	
	4.2	Orifice, Venturi, nozzle, characteristics of Head type flow meters, Rotameter,Magnetic flow meter, Mass flow meter, Vortex flow meter, ultrasonic	
	4.3	**Level Measurement:** Need for level measurement, classification of Level Measurement Techniques.Construction and working of Tubular level gauge, DP cell, ultrasonic, Capacitance and Radar	
		Tutorial : 2	2
5		**Pneumatic and Hydraulic System**	**7**
	5.1	**Pneumatic components**: ISA symbols, Instrument Air and Plant Air. Air compressor system and its accessories.	
	5.2	Linear actuators- Single-acting, Double-acting	
	5.3	Directional control valves , Flow control valves, Sequence valves,Pneumatic logic gates, Pneumatic Circuits-Standard Symbols used for developing pneumatic circuits,	
	5.4	**Hydraulic components**: Hydraulic pumps, Pressure regulation method, Loading valves, Hydraulic valves.	

		Tutorial : 2	2
6		**Electric Actuators**	6
	6.1	Definition, types and selection of Actuators Electrical actuating systems: Electric Motors- Principle of operation and its application: D.C motors - AC motors,- Stepper motors.and servo motor	
	6.2	**VFD:** introduction and Need, working of AC & DC drives. Selection and comparison of pneumatic, hydraulic and electric systems	
		Tutorial : 2	2
		Total	**39+13 = 52**

Textbooks:	
1	B.C Nakra, K.K. Chaudhary, Instrumentation, Measurement and Analysis, Tata McGraw-Hill Education, 01-Oct-2003 - Electronic instruments.
2	Patranabis D, Sensors and Transducers, Prentice Hall India Learning Private Limited; 2 edition (2003).
3	A. K. Sawhney, Puneet Sawhney,A course in Electrical and Electronic Measurement and Instrumentation, Dhanpat Rai and Co. Rai, 1996.
4	Andrew Parr, Hydraulic &pneumatics; A Technicians & Engineers Guide, Second Edition.
5	Andrew Williams, "Applied instrumentation in the process industries", 2 nd Edition, Vol. 1 & 3, Gulf publishing compan.

	Reference Books:
1	Doeblin E.D., Measurement system, Tata McGraw Hill., 4th ed, 2003.
2	Bela G. Liptak, Instrument Engineers' Handbook, Fourth Edition, Volume One: Process Measurement and Analysis, June 27, 2003.
3	Neubert Hermann K. P., Instrument Transducer, 2nd ed., Oxford University Press, New Delhi, 2003.
4	Johnson Curtis D., Process Control Instrumentation Technology, 8th Ed., 2005.
5	S.P. Sukhatme, Heat Transfer, 3rd edition, University Press.
6	B.E. Jones, Instrument Technology.
7	Chortle Keith R., Fundamentals of Test, Measurement Instrument Instrumentation, ISA Publication.
8	Alan S Morris, Measurement and Instrumentation Principles; 3rd Edition.
9	Sawhney A.K., ―Mechanical Measurement‖, Dhanpatrai And Co.
10	Bansal R.K., ―Fluid Mechanics and Hydraulic Machines‖, Laxmi publications.
11	David W. Spitzer, ―Industrial Flow Measurement‖, ISA Publication.

Internal Assessment:

1) Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2) Mid Term test is to be conducted when approx. 50% syllabus is completed.
3) Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**.The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	05 marks
8.	Multiple Choice Questions (Quiz)	05 marks
9.	Peer Review and participation the marks can be left blank (with discretion of faculty)	05 Marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Course Name: Fundamentals Of Additive Manufacturing Technologies (Theory)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	TutoriaL	Theory	TW/ PR	Tut	Total
NOE42	Fundamentals of Additive Manufacturing Technologies (Theory)	03	–	--	03	--	–	03

Fundamentals Of Additive Manufacturing Technologies

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NOE42	Fundamentals of Additive Manufacturing Technologies (Theory)	–	---	01	__	--	01	01

Course Code	Course Name	Examination Scheme					
		Theory			Tem Work	PR & OR	Total
		Internal Assessment		End Sem Exam			
		Mid -Term Test	Continuous Assess ment				
NOE42	Fundamentals of Additive Manufacturing Technologies	20	20	60	–	–	100

	(Theory)						

Course Prerequisite:	
Course Objectives:	
1	Understanding of different additive manufacturing technologies for realizing metallic and non-metallic objects.
2	Link computer interface with the digital manufacturing process and their demonstration using commercially available software
3	Develop a fundamental understanding of different perspectives and recent development in this Additive Manufacturing field
4	Oriented to cover from basic understanding to practical applications of this technology to develop the products
Course Outcomes: After successful completion of the course students will be able to:	
1	Interpet an STL CAM file for manipulation
2	Design 3D files using Open Source 3D CAD modeler
3	Describe Liquid Additive Manufacturing Process
4	Describe The Additive Manufacturing Process
5	Describe Wire based Additive Manufacturing Process
6	Describe Powder Feed-based Additive Manufacturing Process

Fundamentals Of Additive Manufacturing Technologies (Theory)

Module	Contents	Hrs
1	Introduction to Additive Manufacturing(AM), Solid Modeling CAM Modelling For AM, STL File Structure and Configurations Orientation of STL File, Support Structure, Optimal Part Orientation, Classification of Slicing Method, Uniform Slicing of STL files, Adaptive Slicing of STL files, ToolPath Planning.	08
2	Introduction to code-based 3D modeling software OPENSCAD, OPENSCAD Software 3D shapes, Transformations, Boolean operations, Data types & variables Flow control, Modules and functions, List comprehension,2D primitives, Extruding 2D primitives into 3D shapes.	06
3	Liquid AM classification, Photo Polymerization and classification, StereoLithography process (SLA) Fundamentals, SubSystems, Apparatus, Perfactory 3D printing methods, PolyJet 3D printing, AutoStrade's Edart, Solid Ground Curing, Microstereolithography, Robotic SLA.	07
4	Sheet AM Cubic Technologies AM, Kira Paper Lamination Technology, Solidimentation Plastic Sheet Lamination, CAM-LEM, Ennex Corporations Offset Fabbers.	06
5	Classification of Wire AM, Fused Deposition Modelling, Metal Wire AM, Shape Deposition Manufacturing, Electron Beam based Wire beam AM, Laser Metal Wire AM.	06
6	Powder Feed AM, Process Modelling of Powder Feed AM, Laser Beam Based Powder Feed AM, Electron Beam Based Powder Feed AM, Binder Based Powder Feed AM.	06
	Total	**39**

List of Suggested Tutorials (13 Hours)

Sr No	Demonstration/Practical
1	Installation with OpenSCAD
2	Making and manipulating a Cube using OpenSCAD
3	Making cylinder and rotating objects
4	Scaling your Model
5	The sphere primitive and resizing objects
6	Defining and using modules
7	Creating and utilizing modules as separate scripts
8	OpenSCAD variables
9	Creating repeating patterns of parts/models - For loops
10	Rotationally extruding 3D objects from 2D objects
11	Doing math calculations in OpenSCAD
12	Slicing your Model using 3D printer software
13	Configuring a 3d Printer

Note: Suggested List of Tutorials is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging tutorials, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Textbooks:	
1	Introduction To Additive Manufacturing (Paperback, Dr. Sridhar S, Natesh C P).
2	Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing Gibson l D. W. Rosen l B. Stucker.

Internal Assessment:

1) Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2) Mid Term test is to be conducted when approx. 50% syllabus is completed.
3) Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	05 marks
8.	Multiple Choice Questions (Quiz)	05 marks
9.	Peer Review and participation the marks can be left blank (with discretion of faculty)	05 Marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Term Work:	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

COURSE NAME: DISASTER MANAGEMENT

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NOE43	Disaster Management (Theory)	03	---	01	03	---	01	04

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NOE43	Disaster Management (Theory)	20	20	60	---	---	100

Course Objectives:	
1	To understand causes of different types of natural and man-made disasters, global warming, climate change and their effects.
2	To understand causes of different types of mitigation /rehabilitation measures.
3	To understand existing government policies and agencies.
4	To understand financing relief, preventive and mitigation measures.
Course Outcomes: After successful completion of the course students will be able to:	
1	Analyse the impact of global warming, climate change and control their effects on the living and non- living things.
2	Compare and contrast with / from natural disasters and manmade disasters.

3	Make policies and design systems and structures to mitigate the effects of natural and manmade disasters.
4	Prepare the system for increasing public awareness regarding preparation and execution of emergency management programs and the role of various national institutes for disaster management.
5	Implement the resources of financial relief measures.
6	Analyse and implement preventive and mitigation measures in case of disasters.

DISASTER MANAGEMENT (THEORY)

Module	Contents	Hrs
1	**Introduction**	**04**
1.1	Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters.	
1.2	Introduction to global warming and climate change.	
	Tutorial on Module 1	**02**
2	**Natural Disaster and Manmade disasters**	**07**
2.1	Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion.	
2.2	Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	
	Tutorial on Module 2	**02**
3	**Disaster Management, Policy and Administration**	**07**
3.1	Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management Policy and administration:	

3.2	Importance and principles of disaster management policies, command and co- ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	
	Tutorial on Module 3	**02**
4	**Institutional Framework for Disaster Management in India**	**07**
4.1	Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.	
4.2	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 software's for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard	
	Tutorial on Module 4	**02**
5	**Financing Relief Measures**	**07**
5.1	Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters.	
5.2	Ways to approach these teams. International relief aid agencies and their role in extreme events.	
	Tutorial on Module 5	**02**
6	**Preventive and Mitigation Measures**	**07**
6.1	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.	
6.2	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.	
	Tutorial on Module 6	**03**

Total		**52**

Textbooks:	
1	Harsh K.Gupta ,Disaster Management, Universities PressPublications,1st edition,2003
2	O.S.Dagur,Disaster Management: An Appraisal of Institutional Mechanisms in India,Centre for land warfare studies,1st edition,2011.
3	Rajdeep Dasgupta,Disaster management & rehabilitation, Mittal Publications,1st edition,2019.
Reference books:	
1	Jack Pinkowski,Disaster Management Handbook, CRC Press Taylor and Francis group, 1st edition,2008.
2	R B Singh,Natural Hazards and Disaster Management, Vulnerability and Mitigation,Rawat Publications, 1st edition,2006.
3	C.P. Lo Albert, K.W. Yonng,Concepts and Techniques of GIS,Prentice Hall (India) Publications.,2nd edition,2016
Industry articles and case studies:	
1	https://www.britannica.com/event/Chernobyl-disaster
2	https://en.wikipedia.org/wiki/Maharashtra_floods_of_2005

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:
Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon	10 marks

3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Peer Review and Participation	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

COURSE NAME: RELIABILITY ENGINEERING

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NOE44	Reliability Engineering (Theory))	03	---	01	03	---	---	04

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NOE44	**Reliability Engineering (Theory)**	**20**	**20**	**60**	**---**	**---**	**100**

Course Objectives:	
1	To impart various aspects of probability theory.
2	To impart various aspects of system reliability.
3	To understand Maintainability and Availability.
4	To understand Failure Mode, Effects and Criticality Analysis procedure.
Course Outcomes: After successful completion of the course students will be able to:	
1	Understand, apply, and analyze the concept of Probability to engineering problems.
2	Demonstrate various reliability concepts to calculate different reliability parameters.
3	Understand the design for Maintainability and Availability.
4	Compute Failure Mode Effects and Criticality Analysis.

RELIABILITY ENGINEERING (THEORY)

Module	Contents	Hrs
1	**Probability theory**	**08**
1.1	Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. Probability Distributions: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance.	
1.2	Measures of Dispersion: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	
	Tutorial on Module 1	**02**
2	**Reliability Concepts**	**08**
2.1	Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time to Failure (MTTF), MTBF, Reliability Functions.	
2.2	Reliability Hazard Models: Constant Failure Rate, linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	
	Tutorial on Module 2	**02**
3	**System Reliability**	**04**
3.1	System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	
	Tutorial on Module 3	**02**
4	**Reliability Improvement**	**07**
4.1	Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success, Path method, Decomposition method.	
	Tutorial on Module 4	**02**
5	**Maintainability and Availability**	**07**
5.1	System downtime, Design for Maintainability: Maintenance requirements.	
5.2	Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	
	Tutorial on Module 5	**02**

6	**Failure Mode, Effects and Criticality Analysis**	**05**
6.1	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.	
	Tutorial on Module 6	**03**
Total		**52**

Textbooks:	
1	L.S. Srinath, Reliability Engineering, "Affiliated EastWast Press (P) Ltd, 3rd Edition
2	Charles E. Ebeling, Reliability and Maintainability Engineering, Tata McGraw Hill, 4th Edition.
3	B. S. Dhillion C. Singh, Engineering Reliability, John Wiley & Sons,5th edition
Reference books:	
1	P.D.T. Conor, Practical Reliability Engg. John Wiley & Sons,3rd Edition.
2	K.C. Kapur, L.R. Lamber son, Reliability in Engineering Design, John Wiley & Sons,3rdEdition.
3	Murray R. Spiegel, Probability and Statistics, Tata McGraw-Hill Publishing Co. Ltd.,5th edition.

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:
Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Peer Review and Participation	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

COURSE NAME: GREEN TECHNOLOGIES & PRACTICES

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
NOE45	Green Technologies and Practices (Theory)	3	--	1	3	--	1	4

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NOE45	Green Technologies and Practices (Theory)	20	20	60	---	---	100

Rationale: Technology is application of knowledge to practical requirements. Green technologies encompass various aspects of technology which help us reduce the human impact on the environment and create ways of sustainable development. Social equitability, economic feasibility and sustainability are the key parameters for green technology. Today, the environment is racing towards the tipping point at which we would have done permanent irreversible damages to the planet earth. Our current actions are pulling the world towards an ecological landslide which if happens would make destruction simply inevitable. Green technologies are an approach towards savings earth and are necessary. Green technologies are our way out of destruction.

Course Objectives: Students will be learning,

1	To acquire knowledge on the concept of green technologies
2	To understand the principles of Green Chemistry in the Energy efficient technologies.
3	To analyze the methods of reducing CO2 levels in atmosphere for Cleaner Production Project Development and Implementation
4	To evaluate the methods of Pollution Prevention and Cleaner Production Awareness Plan.
5	To analyze the application of Energy Efficacy.
6	To apply the knowledge of Green Fuels during implementation.

Course Outcomes: Students should be able to	
1	Enlist different concepts of green technologies in a project.
2	Describe the principles of Green Chemistry in the Energy efficient technologies.
3	Select the best method for the carbon credits of various activities for Cleaner Production Project Development and Implementation.
4	Evaluate the importance of life cycle assessment for Pollution Prevention and Cleaner Production Awareness Plan.
5	To apply the problems related to Pollution Prevention and Cleaner Production Awareness Plan.
6	To choose the green fuels based on their benefits for sustainable development.

Module	Course Module / Contents		Hours
1	**Introduction to Green Technology**		7
	1.1	Definition- Importance – Historical evolution – advantages and Disadvantages of green technologies.	
	1.2	Factors affecting green technologies.	
	1.3	Role of Industry, Government and Institutions-Industrial Ecology.	

	1.4	Role of industrial ecology in green technology.	
2	**Green Chemistry**		8
	2.1	Principles of Green Chemistry, Green chemistry metrics-atom economy.	
	2.2	E factor, reaction mass efficiency.	
	2.3	Waste: Sources of waste, different types of waste.	
	2.4	Chemical, physical and biochemical methods of waste minimization.	
	2.5	Clean development mechanism: reuse, recovery & recycle.	
	2.6	Raw material substitution: Wealth from waste, case studies.	
3	**Cleaner Production Project Development and Implementation**		09
	3.1	Overview of CP Assessment Steps and Skills, Process Flow Diagram.	
	3.2	Material Balance, CP Option Generation: Technical and Environmental Feasibility analysis.	
	3.3	Economic valuation of alternatives: Total Cost Analysis – CP Financing.	
	3.4	Preparing a Program Plan: Measuring Progress-ISO 14000.	
4	**Pollution Prevention and Cleaner Production Awareness Plan**		10
	4.1	Waste audit: Environmental Statement.	
	4.2	Carbon credit, Carbon trading, Carbon footprint.	
	4.3	Carbon sequestration.	
	4.4	Life Cycle Assessment- Elements of LCA.	
	4.5	Life Cycle Costing.	
	4.6	Eco Labelling.	
5	**Energy Efficacy**		8
	5.1	Availability and need of conventional energy resources: major environmental problems related to the conventional energy resources.	
	5.2	Future possibilities of energy need and availability.	

	5.3	Non-conventional energy sources: Solar Energy-solar energy conversion technologies and devices.	
	5.4	Solar Energy: principles, working and application.	
6	**Green Fuels**		10
	6.1	Definition-benefits and challenges: comparison of green fuels with Conventional fossil fuels with reference to environmental, economic and social impacts- public policies and market driven initiatives.	
	6.2	Biomass energy: Concept of biomass energy utilization, types of biomass energy, conversion processes.	
	6.3	Wind Energy, energy conversion technologies, their principles, equipment and suitability in Indian context.	
	6.4	Tidal and geothermal energy.	
		Total	52

Textbooks:	
1	Pollution Prevention: Fundamentals and Practice' by Paul L Bishop (2000), McGraw Hill International.
2	Pollution Prevention and Abatement Handbook –Towards Cleaner Production by World ank Group (1998), World Bank and UNEP, Washington D.C.
3	Cleaner Production Audit by Prasad Modak, C. Visvanathan and Mandar Parasnis (1995), Environmental System Reviews, No.38, Asian Institute of Technology, Bangkok
4	Handbook of Organic Waste Conversion by Bewik M.W.M.
5	Solar Energy by Sukhatme S.P.

Reference Books:	
1	Energy, The Solar Hydrogen Alternative by Bokris J.O.
2	Non-conventional Energy Sources by Rai G.D.

3	Waste Energy Utilization Technology by Kiang Y. H.
4	Wind, Tidal, Geothermal, Biomass and Non–conventional energy Green fuel by G.D.Rai.

Internal Assessment:

1) Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2) Mid Term test is to be conducted when approx. 50% syllabus is completed.
3) Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	05 marks
8.	Multiple Choice Questions (Quiz)	05 marks
9.	Peer Review and participation the marks can be left blank (with discretion of faculty)	05 Marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

COURSE NAME: FUTURISTIC POWER SYSTEMS

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
NOE46	Futuristic Power System (Theory)	3	--	1	3	--	1	4

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NOE46	Futuristic Power System(Theory)	20	20	60	---	---	100

Course Objectives: Students will be learning,	
1	To explore the state of the art and future trends in power systems.
2	To understand the technical, economic and social challenges in power system evolution.
3	To realize the role and importance of Microgrids if futuristic power systems.
Course Outcomes: Students should be able to,	
1	To solicit the importance of large scale renewable energy integration with existing grid infrastructure.
2	To understand the importance and utility of Energy storage systems in futuristic power systems.

3	To explore large scale micro-grid deployment with RES and ESS integration.
4	To understand the role of communication and IT Infrastructure in power system and related challenges.
5	To explore the potential of Microgrids and its importance in Indian context.

Module	Contents	Hrs
1.	**Introduction:** Present status of worldwide scenario of electricity generation, transmission and distribution; Energy infrastructure-Resilience and Security; Social, Technical and economic challenges; Major trends driving power system evolution; State of the art technologies in power system.	6
2.	**RenewableEnergy Integration:** Review of renewable energy (RE) resources and systems: Solar- PV, Solar Thermal, Wind, Biomass, Micro-hydro and Fuel Cell, comparison of various RE resources; Renewable Energy Policies and present status of integration with existing grid; Large scale integration of renewable energy-Technical challenges, enabling technologies, International requirements; Renewable energy forecasting	12
3.	**Energy Storage Systems (ESS):** Review of energy storage components: Battery, VRB, Ultra-capacitor, Fuel Cells, Pumped Hydro-Storage and flywheels, comparison of ESS technologies; Importance of ESS in futuristic power systems; Aggregated ESS, Distributed ESS; Applications of ESS: Energy Management (Load Leveling and Peak Shifting), Fluctuation Suppression (Intermittency Mitigation), Uninterruptible Power System Low-Voltage Ride Through; Placement of the ESS to Improve Power Quality, Voltage Regulation Using ESS, ESS as Spinning Reserve.	12

4.	**Micro-grid and Smart-grid** Micro-grid evolution: Micro-grid concept, importance in futuristic power system, basic architectures and control, objectives and state of the art technologies; Microgrid as a building block of Smart-grid; Smart-grid concept, Smart Grid versus conventional electrical networks, Smart-grid infrastructure, Smart Grid communication system and its cyber security, International standard IEC 61850 and its application to Smart-grid; Microgrids /smart grid and Electric Vehicles integration. Technical, Economic, Environmental and Social Benefits of Microgrid Operation.	12
5.	**Communication and IT infrastructure:** Requirements of Communication and IT infrastructure in futuristic power systems: various communication protocols, comparison of performance; IEEE standard: IEEE 802.11 Mesh Networking, IEEE 802.15.4-Wireless Sensor Networks; Communications Technologies for Smart metering; Cyber security issues and mitigation techniques.	6
6.	**Microgrids in India:** Microgrids for Rural Electrification, Review of Microgrid Best Practices through Case Studies: Strategic Planning, Operations: Commercial and Financial Considerations; Technical and Social Context.	6
	Total	52

Textbooks:	
1	Microgrids Architectures and Control Edited by Nikos Hatziargyriou, IEEE and Wiley, 2014

2	Energy Storage for Sustainable Microgrid by David Wenzhong Gao, Elsevier, 2015
3	Introduction to the Smart Grid- Concepts, Technologies and Evolution by Salman K. Salman, IET, 2017
4	Energy Storage Systems and Components by Alfred Rufer, CRC Press, 2018
Reference Books:	
1	Energy Efficiency and Renewable Energy Handbook Edited by D. Yogi Goswami and Frank Kreith, 2nd Edition-2016, CRC
2	Clean Energy Microgrids, Edited by Shin'ya Obara and Jorge Morel IET, 2017

3	Hybrid-Renewable Energy Systems in Microgrids- Integration, Developments and Control edited by Hina Fathimaby *et al*., Elsevier WoodHead Publishing, 2018
4	Smart Microgrids: Lessons from Campus Microgrid Design and Implementation edited by Hassan Farhangi, CRC Press 2017
Website Reference / Video Courses:	
1	NPTEL Web Course on: DC Microgrid And Control System Prof. Avik Bhattacharya, IIT Roorkee
2	NPTEL Web Course on Electronics and Distributed Generation Dr. Vinod John Department of Electrical Engineering IISc Bangalore
3	NPTEL Web Course on Introduction to Smart Grid, PROF. N.P. PADHY Department of Electrical Engineering IIT Roorkee PROF. PREMALATA JENA Department of Electrical Engineering
4	NPTEL Web Course on Electric vehicles and Renewable energy, Prof. Ashok Jhunjhunwala, Prof. Prabhjot Kaur, Prof. Kaushal Kumar Jha and Prof. L Kannan, IIT Madras

Internal Assessment:

1) Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2) Mid Term test is to be conducted when approx. 50% syllabus is completed.
3) Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon	10 marks
3	Content beyond syllabus presentation	10 marks

4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	05 marks
8.	Multiple Choice Questions (Quiz)	05 marks
9.	Peer Review and participation the marks can be left blank (with discretion of faculty)	05 Marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

COURSE NAME: WEB DEVELOPMENT LAB

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
NITVS41	**Web Development (Theory)**	**01**	**---**	**---**	**---**	**---**	**---**	**---**
NITVSL41	**Web Development (Lab)**	---	**02**	---	---	**02**	---	**02**

WEB DEVELOPMENT (Theory)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
NITVS41	**Web Development (Theory)**	01	---	---	---	---	---	---

Examination Scheme							
Course Code	Course Name	Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NITVS41	**Web Development (Theory)**	---	---	---	--	---	---

Course Prerequisite: Basics of programming
Course Objectives:

1	To understand the fundamental principles of Web Application Architecture and the digital evolution of web technology.
2	To learn JavaScript, encompassing ES6 features
3	To orient students to the basics of REACT
4	To gain expertise in Angular
5	REST API with Node.js and MongoDB for Frontend and Backend Connectivity.
Course Outcomes: After successful completion of the course, students will be able to:	
1	Select protocols or technologies required for various web applications.
2	Apply JavaScript to develop dynamic web pages.
3	Design front-end applications using different components of React.
4	Develop and deploy an Angular Application
5	Learn to build RESTful APIs with Node.js and Express, integrating MongoDB and handling CRUD operations effectively.
Learning Outcomes:	
1	Select protocols or technologies required to build web applications.
2	Design dynamic web pages using advanced concepts of Java Script
3	Design and implement single-page applications using different components of React.
4	Develop and deploy an Angular Application
5	To build RESTful APIs with Node.js and Express, integrating MongoDB and handling CRUD operations effectively.

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut	Total
NITPCL41	**Web Development (Lab)**	---	**02**	---	---	**02**	---	**02**

Examination Scheme							
Course Code	Course Name	Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NITPCL41	**Web Development (Lab)**	**---**	**---**	**---**	**25**	**25**	**50**

Lab Prerequisite: Basics of programming	
Lab Objectives:	
1	Describe formatting and optimization of media for the web.
2	Apply JavaScript to develop dynamic web pages.
3	Design front-end applications using different components of React.
4	Develop and deploy an Angular Application
5	Build RESTful API
Lab Outcomes: After successful completion of the course students will be able to:	
1	Design and implement responsive web pages using HTML, CSS, and JavaScript
2	Design and implement Single-Page Applications using React.
3	Develop and deploy an Angular Application.
4	To set up and interact with a MongoDB database, perform CRUD operations using Mongoose, and create RESTful API endpoints with Express.js.

Module No	Module Name	Contents	Hrs
1	**Fundamentals of Web Application Architecture and Infrastructure**	Web Application Architecture and Technologies, Working of web browser, Web Infrastructure: HTTP protocol, HTTPS, DNS, TLS, XML, JSON, DOM, URL, URI, REST API. Evolution of the web and key milestones in Web Development history	**01**
2	**Javascript**	Introduction to ES6, Variables, Conditionals and Loops, Functions and Arrow Functions, Events and Event Handling, DOM Manipulation, Setting CSS Styles using JavaScript, Classes and Inheritance, Iterators and Generators, Promise and Asynchronous JavaScript, Client-Server Communication and Fetch API.	**03**
3	**React**	Introduction to React and Setup, JSX and Components, Single page applications, State, Props, Lifecycle Methods, Hooks, Handling Events, Forms, React Router, Styling in React, Advanced React Concepts: Functional Components, Refs, Effects and State Management	**03**
4	**Angular**	Introduction to Typescript, Why Angular? Setting up Angular development environment, Components and Modules, Data binding, Directives, Services, and Dependency Injection, Angular Forms with validation, Routing and Navigation, and HTTP Communication.	**02**
5	**MongoDB**	MongoDB as a NoSQL database, Connecting to MongoDB, Accessing and Manipulating Databases, Using Mongoose for Structured Schema and Validation.	**01**
6	**Building RESTful APIs with Node.js and Express**	Features of NodeJS, Modules, Environment setup, First app, Asynchronous programming, Callback concept, Architecture: Event loops, REPL, Event emitter, Networking module, Buffers, Streams, File system, Web module.Introduction to Express, Installing Express, Creating First Express application, The application, request, and response objects, Configuring Routes,	**03**

		Adding the MongoDB Driver to Node.js, Connecting to MongoDB from Node.js, REST API: Examining the rules of REST APIs, Handling typical CRUD functions (create, read, update, delete), Using Express and Mongoose to interact with MongoDB, Testing API endpoints	
		Total	**13**

Textbooks:	
1	Terry Felke-Morris, Web Development and Design Foundations with HTML5, Pearson, 9th Edition
2	Rediscovering JavaScript, Master ES6, ES7, and ES8, By Venkat Subramaniam, 2018.
3	Learning React Functional Web Development with React and Redux, Alex Banks and Eve Porcello, O'Reilly
4	Boris Cherny, "Programming TypeScript- Making Your Javascript Application Scale", O'Reilly Media Inc.
5	Angular in Action, by Jeremy Wilken, 2018, Manning Publications
6	Simon Holmes Clive Harber, "Getting MEAN with Mongo, Express, Angular, and Node", Manning Publications.
7	Dr. Deven Shah, "Advanced Internet Programming", StarEdu Solutions
Online Resources:	
1	MDN WebDoc
2	https://react.dev/
3	https://angular.io/
4	https://www.mongodb.com/
5	https://nodejs.org/en

WEB DEVELOPMENT (LAB)

Suggested Experiments: Students are required to complete at least 10 experiments.
Star (*) marked experiments are compulsory.

Sr. No.	Name of the Experiment
1*	Design a web page with HTML and CSS
2*	Javascript assignments on variable declaration, control statements, event handling,
3*	DOM Manipulation with Javascript
4*	Asynchronous programming
5	Client Server Communication.
6*	Create a simple React application that displays a list of items fetched from an API using the Fetch API. Display each item as a component with its own state.
7*	Develop a form component in React to accept data from users, process it and display results.
8*	Build a basic Angular application that fetches data from a public API and displays it in a list format. Use Angular's HttpClientModule for making HTTP requests.
9*	Implement a form in Angular that allows users to add new items to a list. Use Angular's FormsModule for form handling and validation.
10	Set up a MongoDB database locally and connect to it using Node.js. Design a schema for the database described.
11*	Write Node.js code to perform CRUD operations using Mongoose.
12*	Create a simple Express.js application that serves static and dynamic HTML files. Set up routes for handling GET and POST requests.
13*	Use Express.js to create RESTful API endpoints for handling these operations.
14	Extend the application to include MongoDB integration. Implement routes for CRUD operations on a collection in the MongoDB database.

Note: Suggested List of Experiments is indicative. However, flexibility lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term Work:	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15 marks, Assessment: 5 marks, Attendance -5)

COURSE NAME: Field Project

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
NITFP41	**Field Project (Theory)**	---	---	---	---	---	---	---
NITFP41	**Field Project (Lab)**	---	---	2*	---	---	2*	02

Field Project

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
NITFP41	**Field Project (Theory)**	---	---	2*	---	---	2*	02

Examination Scheme							
Course Code	Course Name	Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NITFP41	**Field Project (Theory)**	---	---	---	---	---	25

Schemes: A) Addressing Real-World Challenges

Students will identify and tackle real-world challenges within the IT domain, bridging academic theories with practical applications. The course immerses students in real-life IT scenarios, offering insights into industry practices, software development processes, and system management. This hands-on approach

enables students to apply classroom knowledge in areas such as software engineering, data analytics, cybersecurity, or IT infrastructure, refining their technical and professional skills. Additionally, students can gain valuable networking opportunities with industry experts, enhancing their understanding of current trends and technologies. By engaging in dynamic projects, students synthesize their academic learning to explore, design, implement, and present innovative solutions to real-world IT problems.

B) Case Studies and Experiential Learning

Students will engage in experiential learning by developing case studies that connect academic knowledge with real-world IT applications across various sectors, including industry, government, or nonprofit organizations. These case studies involve observing and analyzing IT processes, workflows, or systems during site visits, interviews, or surveys. By applying critical thinking and problem-solving skills, students will identify inefficiencies or challenges in these processes and propose potential enhancements or innovative IT-based solutions to optimize or transform existing operations.

Course Prerequisite:

- Basic Computing knowledge
- Any Programming Language
- Algorithm and flowcharts/use cases
- Business Process/ Operations

Course Objectives:

1	To engage students in field visits with the aim of identifying and formulating problem statements based on observations in industries, government organizations, nongovernmental organizations, and broader societal contexts.
2	To facilitate experiential learning by developing case studies that analyze real-world IT processes, workflows, or systems, enabling students to propose innovative enhancements through critical observation and analysis.
3	To bridge academic theories with practical applications, fostering a deeper understanding of IT principles and actionable insights for real-world challenges.
4	To develop teamwork, communication, and collaboration skills, enabling students to effectively achieve project goals and meet deadlines in a professional environment.

Course Outcomes:

After successful completion of the course, students will be able to:

1	To identify and resolve the issues with industry & society at large, to provide practical solutions for real-world challenges.
2	To implement novel and efficient solutions fostering interdisciplinary collaboration in addressing challenges.
3	To apply appropriate techniques, resources and modern engineering tools, to improve the analytical, design, and problem-solving skills to abreast with the booming technologies.
4	Cultivation of effective teamwork abilities, facilitating collaboration and synergy among individuals to achieve common goals.

Field Project

Module	Contents	Hrs
1	**Project Planning and Proposal Development:** Defining project objectives and scope, conducting literature review and background research, developing project proposal and timeline, Identifying required resources and constraints.	**06**
2	**Project Ideation & Planning:** Overview of key IT domains, the feasibility analysis of project ideas, creation of a project timeline and resource plan, and requirement-gathering techniques (interviews, surveys, and observations).	**06**
3	**Design and Implementation:** Selecting appropriate methodologies and Simulation tools, designing system architecture and components, Prototyping and testing system functionalities, iterative development and troubleshooting.	**08**
4	**Documentation and Reporting:** Maintaining detailed project documentation, Recording progress, challenges and solutions,	**06**

	Writing technical reports and documentation, Creating presentations for project updates and final presentations	
	Total	**26**

COURSE NAME: Introduction to Innovation and Entrepreneurship for Engineers

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW /PR	Tut	Total
NITEM38	Introduction to Innovation and Entrepreneurship for Engineers	—	---	02	--	--	02	02

Introduction to Innovation and Entrepreneurship for Engineers

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned				
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut		Total
NITEM38	Introduction to Innovation and Entrepreneurship for Engineers	—	---	02	—	--	02		02

Course Code	Course Name	Examination Scheme						
		Theory			Term Work	PR & OR	Total	
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NITEM38	Introduction to Innovation and Entrepreneurship for Engineers	--	—	--	25	---	25	

Course Prerequisite:	
Course Objectives:	
1	Understand the concepts and theories of innovation and entrepreneurship within engineering disciplines.
2	Develop critical thinking and problem-solving skills necessary for identifying and evaluating entrepreneurial opportunities.
3	Gain practical experience in ideation, prototyping, and validation of innovative solutions to engineering challenges.
4	Explore the role of engineering in addressing societal and environmental challenges through innovation and entrepreneurship.
Course Outcomes: At the end of the course the student will gain the capability to:	
1	Understand principles of innovation and entrepreneurship.
2	Identify and evaluate entrepreneurial opportunities.
3	Understand and Apply design thinking and innovation methodologies.
4	Develop and validate viable business models and innovative solutions.
5	Understand and demonstrate ethical practices in innovation and entrepreneurship
6	Demonstrate entrepreneurial mind set and skills.

Introduction to Innovation and Entrepreneurship for Engineers

Module	Contents	Hrs
1	Introduction to Innovation and Design Thinking	06
1.1	Overview of innovation concepts and importance in engineering.	
1.2	Types of innovation and innovation processes.	
1.3	Introduction to design thinking methodology.	
1.4	Applying design thinking principles to engineering challenges.	
1.5	Empathy mapping and user journey analysis.	

1.6	Iterative design process and user testing.	
2	Opportunity Identification, Ideation	04
2.1	Techniques for identifying customer needs and pain points.	
2.2	Idea generation exercises and brainstorming sessions.	
2.3	Problem-solving through human-centered design.	
3	Prototyping and MVP Development	04
3.1	Introduction to prototyping techniques and tools.	
3.2	Minimum viable product (MVP) development and validation.	
3.3	Rapid iteration and feedback gathering.	
4	Introduction to Entrepreneurship	04
4.1	Overview of entrepreneurship concepts and mindset.	
4.2	Role of entrepreneurs in driving economic and social change.	
4.3	Characteristics of successful entrepreneurs. - Case Studies	
5	Business Model Innovation and Validation	04
5.1	Introduction to business model canvas and value proposition design.	
5.2	Revenue models, pricing strategies, and cost structure analysis.	

5.3	Techniques for market research and customer validation.	
5.4	Identifying target markets and understanding customer needs.	
6	Legal and Ethical Considerations	04
6.1	Intellectual property rights and patents in engineering innovation.	
6.2	Ethical considerations in entrepreneurship and engineering practice.	
6.3	Social responsibility and sustainability in innovation and entrepreneurship.	
	Total	**26**

Textbooks:	
1	"Entrepreneurship Development and Small Business Enterprises" by Poornima M. Charantimath
2	"Innovation and Entrepreneurship: Practice and Principles" by Peter F. Drucker
3	"Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers" by Alexander Osterwalder and Yves Pigneur
4	"Innovative India: Science and Technology Entrepreneurship" by K. Vijayaraghavan and Rajan Srikanth
5	"Startup Nation: Making India a Startup Ecosystem" by Dr. H.K. Mittal
6	"Entrepreneurship: Theory, Process, and Practice" by Kuratko, Hornsby, and Covin:
7	"Zero to One: Notes on Startups, or How to Build the Future" by Peter Thiel and Blake Masters
Websites :	
1	Startup India (startupindia.gov.in): • Provides resources, guidelines, and support for startups and entrepreneurs in India, including information on funding, policies, and events.

2	National Entrepreneurship Network (wadhwanifoundation.org/national-entrepreneurship-network): • Offers resources, workshops, and programs for entrepreneurship education and ecosystem development in India.
3	MIT OpenCourseWare (ocw.mit.edu): • Offers free online courses on entrepreneurship and innovation, including lecture notes, assignments, and case studies from MIT's entrepreneurship curriculum.
4	Stanford eCorner (ecorner.stanford.edu) • Features a rich collection of videos, podcasts, and articles on entrepreneurship and innovation from Stanford University, including talks by successful entrepreneurs and industry experts.
5	Coursera (coursera.org) • Provides online courses on entrepreneurship and innovation from top universities and institutions, allowing students to learn at their own pace and earn certificates.
6	TiE (The Indus Entrepreneurs) (tie.org) • A global nonprofit organization dedicated to fostering entrepreneurship through mentoring, networking, and education, with many chapters in India offering local support and events.
Additional Resources:	
1	Entrepreneurship Development Institute of India (EDII) (ediindia.org) • Provides entrepreneurship education, training, and research programs, as well as workshops and seminars on various aspects of entrepreneurship.
2	Harvard Business Review (hbr.org) • Offers articles, case studies, and insights on innovation, entrepreneurship, and business strategy from industry experts and thought leaders.
3	Khan Academy (khanacademy.org) • Offers free educational resources, including lessons on entrepreneurship, economics, and business fundamentals.

Term Work :	
The Assessment will be based on a set of 5 activities of 5 marks each. The suggested list of activities:	
1	Individual and group assignments (e.g., business model canvas, market research report).
2	Presentations and pitches for venture ideas.
3	Participation in discussions and workshops.
4	Reflection papers or journals documenting personal learning and growth.
5	Presentation of innovation projects by students.
6	Feedback and peer evaluation of prototypes.
7	Reflection on the innovation process and lessons learned.