

Curriculum of Diploma Programme
in
Computer Science and Engineering



**Department of Science, Technology and Technical
Education (DSTTE), Govt. of Bihar**

**State Board of Technical Education
(SBTE), Bihar**

Semester – VI

Teaching & Learning Scheme

Course Codes	Category of course	Course Titles	Teaching & Learning Scheme (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
2418601	PCC	Cloud Computing	03	-	04	02	09	06
2418602	PCC	Computer Network with Linux & Windows	03	-	04	02	09	06
2418603	PEC	Programme Electives* - Any One	03	-	04	02	09	06
2400604	OEC	Open Electives**/ COE (Advanced - Any One)	03	-	04	02	09	06
2418605	PSI	Major Project (Common for all programmes)	-	-	08	04	12	06
Total			12	-	24	12	48	30

Note: Prefix will be added to Course Code if applicable (T for Theory, P for Practical Paper and S for Term Work)

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

*: Introduction to Machine Learning/ Mobile Application Development

** : 3D Printing & Design /Artificial Intelligence (AI)/ Drone Technology/ Electric Vehicle/ Industrial Automation & Control/ IOT/ Robotics/Transformer Manufacturing and Repairing/ Optical Fiber and 5G Communication

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

Semester - VI Assessment Scheme

Course Codes	Category of course	Course Titles	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment(LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2418601	PCC	Cloud Computing	30	70	20	30	20	30	200
2418602	PCC	Computer Network with Linux & Windows	30	70	20	30	20	30	200
2418603	PEC	Programme Electives* - Any One	30	70	20	30	20	30	200
2400604	OEC	Open Electives**/ COE (Advanced - Any One)	30	70	20	30	20	30	200
2418605	PSI	Major Project (Common for all programmes)	-	-	20	30	50	100	200
Total			120	280	100	150	130	220	1000

Note: Prefix will be added to Course Code if applicable (T for Theory, P for Practical Paper and S for Term Work)

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

*: Introduction to Machine Learning/ Mobile Application Development

** : 3D Printing & Design /Artificial Intelligence (AI)/ Drone Technology/ Electric Vehicle/ Industrial Automation & Control/ IOT/ Robotics/Transformer Manufacturing and Repairing/ Optical Fiber and 5G Communication

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2418601

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1a.</i> Explain different service and deployment models in cloud computing.</p> <p><i>TSO 1b.</i> Explain popular cloud stacks and their use cases.</p> <p><i>TSO 1c.</i> Evaluate the benefits, risks, and challenges associated with cloud computing</p> <p><i>TSO 1d.</i> Illustrate economic models and Service Level Agreements (SLAs) in cloud computing</p>	<p>Unit-1.0 Introduction to Cloud Computing</p> <p>1.1 Definition and evolution of Cloud Computing and Cloud -Enabling Technologies,</p> <p>1.2 Service and Deployment Models</p> <p>1.3 Popular Cloud Stacks (commercial/paid and open sourced) and Use Cases</p> <p>1.4 Benefits, Risks, and Challenges of Cloud</p> <p>1.5 Computing Economic Models and SLA</p>	CO-1
<p><i>TSO 2a.</i> Describe the functions of data centers components</p> <p><i>TSO 2b.</i> Analyze design considerations like requirements, power, efficiency, and redundancy</p> <p><i>TSO 2c.</i> Calculate of cloud data Centre</p> <p><i>TSO 2d.</i> Explain function of cloud management</p> <p><i>TSO 2e.</i> Explain deployment steps of cloud software.</p>	<p>Unit-2.0 Cloud Infrastructure</p> <p>2.1 Historical Perspective of Data Centers</p> <p>2.2 Datacenter Components: IT Equipment and Facilities</p> <p>2.3 Design Considerations: Networking, Requirements, Power, Efficiency, & Redundancy</p> <p>2.4 Power Calculations, PUE and Challenges in Cloud Data Centers</p> <p>2.5 Cloud Management and Cloud Software Deployment Considerations</p>	CO-2
<p><i>TSO 3a.</i> Recognize the necessity of virtualization in IT environments.</p> <p><i>TSO 3b.</i> Differentiate between types of virtualizations.</p> <p><i>TSO 3c.</i> Identify the appropriate hypervisors like VMware and Xen.</p> <p><i>TSO 3d.</i> Explain the various VM-based operations like creation, configuration, and management of VMs.</p> <p><i>TSO 3e.</i> Explain the virtualization concepts, technologies, and methods.</p>	<p>Unit-3.0 Introduction to Virtualization</p> <p>3.1 Definition and basic concepts of virtualization.</p> <p>3.2 Understanding the need for virtualization in IT environments.</p> <p>3.3 Types of Virtualizations</p> <ul style="list-style-type: none"> • Full virtualization vs. para-virtualization. • Hardware virtualization vs. software virtualization. <p>3.4 Hypervisors</p> <ul style="list-style-type: none"> • Types of hypervisors: Type 1 (bare-metal) and Type 2 (hosted). • Role of Hypervisor • Popular hypervisors: VMware, Xen. <p>3.5 Virtual Machines (VMs)</p> <ul style="list-style-type: none"> • Creating, configuring, and managing virtual machines. • Understanding VM snapshots and cloning. <p>3.6 Storage Virtualization</p> <ul style="list-style-type: none"> • Virtualized storage concepts. • Understanding storage virtualization technologies and methods. 	CO-3

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 4a.</i> Explain the functions of cloud storage.</p> <p><i>TSO 4b.</i> Explain the function of different distributed file systems.</p> <p><i>TSO 4c.</i> Explain the function of cloud databases, focusing on MongoDB.</p> <p><i>TSO 4d.</i> List and explain the Cloud object storage solutions such as Amazon S3, OpenStack Swift, and Google Cloud Storage.</p>	<p>Unit-4.0 Cloud Storage</p> <p>4.1 Introduction to Storage Systems</p> <p>4.2 Cloud Storage Concepts</p> <p>4.3 Cloud Databases (MongoDB)</p> <p>4.4 Cloud Object Storage (Amazon S3, OpenStack Swift, Google Cloud Storage object: cold line)</p>	CO-4
<p><i>TSO 5a.</i> Explain the given security related risk in Cloud Computing.</p> <p><i>TSO 5b.</i> Explain then specified feature of key security terminology for data security</p> <p><i>TSO 5c.</i> Write steps to implement the given Technology for Securing the Data on cloud</p> <p><i>TSO 5d.</i> Explain the given feature of Security-AS-A-Cloud Service.</p>	<p>Unit-5.0 Security in Cloud Computing</p> <p>5.1 Cloud Security Fundamentals</p> <p>5.2 Cloud Risk, Cloud Risk division</p> <ul style="list-style-type: none"> ▪ Polity and Organizational Risks ▪ Technical Risks ▪ Legal Risks <p>5.3 Technologies for Data Security risk.</p> <p>5.4 Digital identity and access management,</p> <p>5.5 Content level security</p> <p>5.6 Security-AS-A-Cloud Service</p>	CO-5

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2418601

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<p><i>LSO 1.1.</i> Use Goggle Doc to make spreadsheet and notes</p> <p><i>LSO 1.2.</i> Configure cloud using Just Cloud</p>	1.	<p>a) Perform Collaborative Document Editing with Google Docs</p> <p>b) Set Up and Configuring Just Cloud for Cloud Storage</p>	CO-1, CO-2
<p><i>LSO 2.1.</i> Upload, download, and share files on different cloud storage (e.g., Dropbox, Google Drive).</p> <p><i>LSO 2.2.</i> Create accounts on any one of Amazon S3, OpenStack Swift, Google Cloud Storage.</p> <p><i>LSO 2.3.</i> Create virtual machine</p>	2.	<p>a) Sign up for any one of Amazon S3, OpenStack Swift, Google Cloud</p> <p>b) Configure the account for administrative control</p> <p>c) Perform File Management in Cloud Storage Platforms</p> <p>d) Create a virtual machine Using hypervisor</p>	CO-3 and CO-4
<p><i>LSO 3.1</i> Install MongoDB on a cloud instance.</p> <p><i>LSO 3.2</i> Create buckets/containers</p> <p><i>LSO 3.3</i> Implement Cloud Object Storage Solutions</p>	3	<p>a) Set Up MongoDB on AWS EC2 Instance</p> <p>b) Create buckets/containers and upload objects</p> <p>c) Implement Cloud Object Storage Solutions</p>	CO4
<p><i>LSO 4.1</i> Implement Access Controls and DLP Solutions</p> <p><i>LSO 4.2</i> Set Up Access Management Policies in AWS / Google Cloud</p> <p><i>LSO 4.3</i> Recover Data using loss Prevention (DLP) Tools</p>	4.	<p>a) Configure access controls to implement data loss prevention (DLP) solutions to prevent unauthorized access and data leakage.</p> <p>b) Set up access management policies and roles using cloud service provider consoles</p>	CO-5

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 4.4 Implement Role-Based Access Control in Cloud Environments LSO 4.5 Access Control Lists (ACLs) Configuration in AWS S3 and Google Cloud Storage LSO 4.6 Implement Security-as-a-Service (SECaaS) in cloud		c) Implement Data Security Technologies in Cloud Implement Security-as-a-Service (SECaaS)	

Note: In addition to above listed practical, students are suggested to practice all the examples covered by the teacher during theory sessions.

L) Suggested Term Work and Self Learning: S2418601 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. Micro Projects:

A single micro-project will be assigned to each student at the beginning of the semester. In the first four semesters, micro-projects will be conducted in groups. However, in the fifth and sixth semesters, students are encouraged to undertake individual micro-projects to enhance their problem-solving skills and confidence, preparing them for industry projects. In exceptional cases where group projects are necessary, the group size should not exceed three students.

The micro-project may involve industry applications, internet-based projects, workshops, laboratory tasks, or fieldwork. Each micro-project should cover at least two Course Outcomes (COs), integrating Program Outcomes (PrOs), Unit Outcomes (UOs), and Additional Desirable Outcomes (ADOs). Students must maintain a dated work diary documenting their individual contributions to the project and present a seminar on their work before submission. The total duration of the micro-project should be at least 16 student engagement hours throughout the semester. Students are required to submit their micro-projects by the end of the semester to foster industry-oriented competencies.

A suggested list of micro-projects is provided below, and additional projects may be included by faculty:

- a) Prepare a case study report on Amazon Cloud Services.
 - b) Prepare a case study report on Google App Engine.
 - c) Build infrastructure as a service using OpenStack.
 - d) Develop a Personal Cloud using a custom cloud solution and Raspberry Pi.
- (Students may use file and sequence data types to develop above listed applications)

c. Other Activities:

- Analyze real-world case studies of organizations implementing cloud computing solutions.
- Join online courses or certifications in cloud computing platforms such as AWS, Azure, or Google Cloud.
- Set up personal cloud environments using platforms like AWS Free Tier, Google Cloud Platform (GCP) Free Tier
- Participate in hackathons or coding competitions focused on cloud computing challenges.

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	15%	20%	20%	10%	20%
CO-2	20%	25%	20%	20%	20%	10%	20%
CO-3	25%	25%	25%	20%	20%	30%	20%
CO-4	20%	20%	20%	20%	20%	30%	20%
CO-5	20%	25%	20%	20%	20%	20%	20%
Total Marks	30	70	20	20	10	20	30
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

** : Mentioned under point- (N)

: Mentioned under point- (O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

- A) Course Curriculum Detailing:** This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2418602

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO1.a Categories computer network based on scope and connection. TSO1.b Explain the use of basic network services TSO1.c Compare the layered structure of OSI and TCP/IP. TSO1.d Explain the functions of each layer of the TCP/IP model. TSO1.e Differentiate different network topologies	Unit-1.0 Introduction to Computer Networks 1.1 Introduction to Computer Networks, Advantages of Computer Networks, Types of Computer Networks 1.2 Basic Network services: File sharing, device sharing, Internet Connection Sharing 1.3 Network Communication Models: OSI Reference Model and function of each layer, TCP/IP Model, and mapping of OSI layers with TC/IP model 1.4 Network Topologies: Bus Topology, Ring Topology, Star Topology, Mesh Topology, Tree Topology	CO-1
TSO.2.a Explain the characteristics of different wired media TSO.2.b Select appropriate transmission media for a given network. TSO.2.c Explain the different modes of data transmission TSO.2.d Describe the functions of various network connecting devices TSO.2.e Explain the purpose of Firewall in a network	Unit-2.0 Transmission media, mode, and Network Device: 2.1 Wired Media – Coaxial, UTP, STP, Fiber Optic Cables 2.2 Wireless Media- Electromagnetic spectrum, Radio Transmission, Microwave Transmission, Infrared Transmission, Satellite Communication 2.3 Mode of Communication: Simplex, Half Duplex, Full Duplex 2.4 Network connecting Devices Network Interface Cards (NICs), Modem, Switches- Layer2 and Layer3, Routers, Gateways, RJ45 & RJ11 connectors 2.5 Concept of Firewall and its use in Networking	CO-2
TSO.3.a Differentiate different Network computing models TSO.3.b Calculate subnet ID and subnet mask for a given IP address TSO.3.c Explain the concept of classless Addressing TSO.3.d Explain the function of network address translation	Unit-3.0 Network Computing Models and Network Layer 3.1 Network Computing Models: Architecture and functionality of - Client-server, peer-to-peer, distributed computing 3.2 Internet Protocol - Logical Addressing - IPv4 Address	CO-3

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.3.e Explain the structure of the IPv6 Address scheme	<ul style="list-style-type: none"> - Address Space - Notations - Classful Addressing: - Net-id, Host-id, Subnet Mask - Subnetting - Classless Addressing: Super netting - Network Address Translation (NAT) - Introduction to IPv6 Address - Role and functions of network gateways 3.3 Address Mapping, Error Reporting	
TSO.4.a Configure IP address and subnet on the Linux Platform TSO.4.b Configure network routing and DNS settings. TSO.4.c Configure bridge interfaces on Linux systems TSO.4.d Configure VLANs on Linux system TSO.4.e Diagnose the common network issues using Linux	Unit-4.0 Networking with Linux 4.1 Configuring IP addresses manually and through DHCP on a Linux system. 4.2 Configure network interfaces/devices/links <ul style="list-style-type: none"> - Configuration of different network services/protocols <ul style="list-style-type: none"> - Domain Name System (DNS) - Dynamic Host Configuration Protocol (DHCP) - File Transfer Protocol (FTP) - web server for hosting websites - Hypertext Transfer Protocol (HTTP) 4.3 Network Interface Bonding 4.4 Internetworking on Linux Systems: Bridging 4.5 Remote Access 4.6 Network troubleshooting tool	CO-4
TSO.5.a Configure IP address and subnet on the Windows TSO.5.b Configure the network interface card using the Windows platform TSO.5.c Configure different application layer protocols on the Windows Platform TSO.5.d Diagnose the common network issues using Windows	Unit-5.0 Networking with Windows 5.1 Network Configuration 5.2 Configuration of different network services <ul style="list-style-type: none"> - Domain Name System (DNS) - Dynamic Host Configuration Protocol (DHCP) - File Transfer Protocol (FTP) - web server for hosting websites - Hypertext Transfer Protocol (HTTP) 5.3 Network Security 5.4 Remote Access 5.5 Network Troubleshooting	CO-5

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2418602

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
LSO.1.1 Share resources on a Network LSO.1.2 Identify the topology in the given Network.	1.	Share Files/Folders, Devices, and Printers in the Network and access the shared resource from the other node.	CO-1
LSO.2.1 Make straight UTP cable LSO.2.2 Make cross UTP cable LSO.2.3 Install Repeater on a network LSO.2.4 Install Layer-2 switch on a network LSO.2.5 Install S/w-based firewall on a network	2.	<ul style="list-style-type: none"> • Prepare and test straight UTP cable for data transfer • Prepare and test cross UTP cable for data transfer • Create wi-fi environment • Configure and test Repeater in network • Configure and test Layer-2 Switch in a network • Install and Configure firewall on a network 	CO-2
LSO.3.1 Configure static IP addresses in the Computer system LSO.3.2 Analyze IP packets LSO.3.3 Configure NAT to access the internet using a single public IP address	3.	<ul style="list-style-type: none"> • Configure static IP addresses in network and internet settings • Run Wireshark to analyze IP packets • Configure NAT to enable devices on a private network to access the internet using a single public IP address 	CO-3
LSO.4.1 Configure the network interface on a Linux Platform LSO.4.2 Configure DHCP on Linux Platform LSO.4.3 Configure FTP on Linux Platform LSO.4.4 Configure Web server on Linux Platform LSO.4.5 Configure bridge interfaces on Linux systems LSO.4.6 Troubleshoot the network issues using Linux commands	4.	<ul style="list-style-type: none"> • Configure the network interface using the Linux command • Configure a DHCP server to dynamically assign IP addresses in the Linux system. • Create an FTP server for file transfer in Linux system. • Set up a web server for hosting websites in Linux system. • Configure bridge interfaces on Linux systems • Troubleshoot the network issues using Linux command in the Linux system 	CO-4
LSO.5.1 Configure DHCP on Windows Platform LSO.5.2 Configure FTP on Windows Platform LSO.5.3 Configure Web server on Windows Platform LSO.5.4 Troubleshoot the network issues using Windows commands	5.	<ul style="list-style-type: none"> • Configure a DHCP server to dynamically assign IP addresses on the Windows system. • Create an FTP server for file transfer on the Windows system. • Set up a web server for hosting websites on the windows system. • Troubleshoot the network issues using windows command in windows system 	CO-5

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J) **Theory Session Outcomes (TSOs) and Units: T2418603A**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Differentiate Artificial intelligence and machine learning TSO 2a. Classify given dataset TSO 3a. Explain preprocessing processes of data TSO 4a. Explain technique of data normalization TSO 5a. Split dataset into train, test and validation sets.	Unit-1.0 Introduction to Machine Learning (ML) 1.1 Overview of Artificial Intelligence (AI) Introduction to ML, Relationship between AI & ML, Difference between AI & ML 1.2 Datasets Type of datasets, Text Datasets, Image Datasets, Time Series Datasets, Spatial Datasets, Graph Datasets 1.3 Preprocessing and normalization Data Cleaning, Data Transformation, Feature Encoding, Dimensionality Reduction, Feature Selection, Data Normalization 1.4 Dataset division test, train, and validation sets, Cross-validation.	CO-1
TSO 2a. Explain machine learning process TSO 2b. Discriminate supervised, unsupervised, and reinforcement learning TSO 2c. Describe the real-life machine learning examples.	Unit-2.0 Fundamental Elements of Machine Learning 2.1 Applications of Machine Learning, processes involved in Machine Learning. 2.2 Machine Learning Techniques Supervised Learning, Unsupervised Learning, Reinforcement Learning 2.3 Real life examples of Machine Learning.	CO-2
TSO 3a. Explain the advantages and challenges related to K-nearest neighbor classifier. TSO 3b. Differentiate between linear and logistic regression. TSO 3c. Use different evaluation measures to quantify the variation of data points from a regression line TSO 3d. Evaluate the performance of classification models.	Unit-3.0 Supervised Learning 3.1 Classification and Regression, K-Nearest Neighbor, Linear Regression, Logistic Regression 3.2 Evaluation Measures, Sum of squares error (SSE), Mean squares error (MME), R-square, confusion matrix, precision, recall, F-Score, ROC-Curve	CO-3
TSO 4a. Explain clustering and its challenges. TSO 4b. Differentiate between hierarchical, agglomerative, and divisive clustering. TSO 4c. Differentiate Extrinsic Measures and Intrinsic Measures	Unit 4.0 Unsupervised Learning 4.1 Introduction to Clustering Types of Clustering, Hierarchical, Agglomerative Clustering, Divisive clustering 4.2 Evaluation measures for clustering: Extrinsic Measures, Intrinsic Measures	CO-4
TSO 5a. Explain the need of dimensionality reduction techniques with example. TSO 5b. Differentiate between PCA, LDA, and ICA.	Unit-5.0 Dimensionality Reduction Techniques 5.1 Principal component Analysis (PCA), Linear discriminant Analysis (LDA), Independent component Analysis (ICA)	CO-5

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2418603A

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use pandas library for data analysis. LSO 1.2. Apply normalization techniques on a given dataset. LSO 1.3. Use scikit-learn to split datasets into train, test, and validation sets LSO 1.4. Apply train, test, and validation technique on given dataset	1.	a. Import and export data using Pandas library functions. b. Use standard scalar and minimax normalization techniques on a given dataset. c. Split datasets into train, test, and validation sets. d. Apply k-fold validation technique on a given dataset.	CO-1
LSO 2.1. Write, execute python program to implement k-nearest neighbor classifier. LSO 2.2. Write, execute python program to implement linear regression. LSO 2.3. Write, execute python program to implement logistic regression. LSO 2.4. Apply different performance measures used in python.	2.	a. Implement k-nearest neighbor Classifier using python. b. Implement linear regression using python. c. Implement logistic regression using python. d. Implement various evaluation measures using python.	CO-2, CO-3
LSO 3.1. Write and execute python program to implement K-mean clustering technique. LSO 3.2. Write and execute python program to implement fuzzy C-mean clustering technique.	3.	a. Implement K-mean clustering using python. b. Implement fuzzy C-mean clustering using python.	CO-1, CO-4
LSO 4.1. Write and execute python program to implement Principle Component Analysis (PCA) method. LSO 4.2. Write and execute Python program to implement Linear discriminative analysis (LDA) method.	4.	a. Implement Dimensionality reduction using Principle Component Analysis (PCA) method. b. Implement Dimensionality reduction using the Linear discriminative analysis (LDA) method.	CO-1, CO-5 CO-1, CO-5

L) Suggested Term Work and Self-Learning: S2418603A Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. Micro Projects:

1. Prepare a report on recent classifiers (supervised learning) used in the research/real-time project.
2. Prepare a report on recent clustering techniques (unsupervised learning) used in the research/real-time project.
3. Make a small project on Loan Prediction using Machine Learning on a Kaggle dataset named "Loan Prediction Problem Dataset". The link to the dataset is- <https://www.kaggle.com/datasets/altruistdelhite04/loan-prediction-problem-dataset>.
4. Prepare a presentation on different datasets with their salient points used in classification and clustering from UCI and Kaggle repositories.

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J) **Theory Session Outcomes (TSOs) and Units: T2418603B**

Major Theory Session Outcomes (TSOs)	Units	Relevant Cos Number(s)
<p>TSO 1a. Explain the differences and similarities between major mobile application ecosystems</p> <p>TSO 1b. Highlighting the key capabilities introduced with each generation.</p> <p>TSO 1c. Explain different connection types in mobile app development.</p> <p>TSO 1d. Explain mobile application development Life Cycle.</p>	<p>Unit-1.0 Basics of Mobile Application Architecture</p> <p>1.1 Overview of mobile applications and ecosystems (iOS, Android, etc.)</p> <p>1.2 Introduction to mobile phone generations – 1G to 5G</p> <p>1.3 Mobile OS Architectures</p> <p>1.4 Smart phone architecture-ARM (Advance RISC Machine)</p> <p>1.4.1 Kernel structure</p> <p>1.4.2 Intel architectures</p> <p>1.4.3 iOS and Windows</p> <p>1.5 Mobile Application Architectures: Client-Server</p> <p>1.5.1 Connection Types</p> <p>1.6 The Mobile Application Development Lifecycle</p> <p>1.7 Android Stack</p> <p>1.8 Android Applications Structure</p>	CO-1
<p>TSO 2a. Explain how to work with Shared Preferences for lightweight data storage.</p> <p>TSO 2b. Describe the importance of persistent data storage for complex data management.</p> <p>TSO 2c. Explain the role of Content Provider classes in Android for sharing data between applications.</p> <p>TSO 2d. Classify layout in various categories.</p> <p>TSO 2e. Highlight the importance of persistent data storage for complex data management.</p>	<p>Unit-2.0 Content Providers and Data Sharing</p> <p>2.1. Using preferences</p> <p>2.1.1. Working with Shared Preferences</p> <p>2.1.2. Preference access permissions</p> <p>2.2. Using the filesystem</p> <p>2.2.1. Creating files</p> <p>2.2.2. Accessing files</p> <p>2.2.3. Files as raw resources</p> <p>2.2.4. XML file resources</p> <p>2.2.5. External storage via an SD card</p> <p>2.3. Persisting data to a database</p> <p>2.3.1. Building and accessing a database</p> <p>2.3.2. Using the sqlite3 tool</p> <p>2.4. Working with Content Provider classes</p> <p>2.4.1. Using an existing Content Provider</p> <p>2.4.2. Creating a Content Provider</p> <p>2.5 Overview of Android Layouts</p> <p>2.5.1 Introduction to Layouts</p> <p>2.5.2 Understanding the purpose of layouts Android apps.</p> <p>2.6 Types of Layouts: Linear Layout, Relative Layout, Constraint Layout, Frame Layout</p> <p>2.7 Adaptive Layouts with Fragments</p>	CO-2
<p>TSO 3a. Explain method to create an Activity class in Android.</p>	<p>Unit-3.0 Interface and Layout in Android</p> <p>3.1. Creating the Activity</p> <p>3.1.1 Creating an Activity class</p>	CO-3

Major Theory Session Outcomes (TSOs)	Units	Relevant Cos Number(s)
<p>TSO 3b. Comprehend the role and usage of common views in Android.</p> <p>TSO 3c. Explain method to create views that are defined through XML.</p> <p>TSO 3d. Explain method to efficiently use resources and animations to create responsive and visually appealing applications.</p>	<p>3.1.2 Exploring the Activity lifecycle</p> <p>3.2 Working with views</p> <p>3.2.1 Exploring common views</p> <p>3.2.2 Using a List View</p> <p>3.2.3 Multitasking with Handler and Message</p> <p>3.2.4 Creating custom views</p> <p>3.2.5 Understanding layout</p> <p>3.2.6 Handling focus</p> <p>3.2.7 Grasping events</p> <p>3.3 Using Resources</p> <p>3.3.1 Supported resource types</p> <p>3.3.2 Referencing resources in Java</p> <p>3.3.3 Defining views and layouts through XML resources</p> <p>3.3.4 Externalizing values</p> <p>3.3.5 Providing animations</p> <p>3.4 Exploring the Android Manifest File</p>	
<p>TSO 4a. Explain the foundational components of Android UI.</p> <p>TSO 4b. Explain the method to create UI elements that are used to build the structure of Android applications.</p> <p>TSO 4c. Explain the function of Advanced UI Components for Enhanced User Experiences</p> <p>TSO 4d. Apply menu and dialogs to Create Engaging and Interactive Android Applications</p> <p>TSO 4e. Explain methods to create effectively use different UI components to improve the user experience and app functionality.</p>	<p>Unit-4.0 Android User Interface Components</p> <p>4.1 Basics of Android UI Components</p> <p>4.1.1 Introduction to Android UI Components: Overview of Views and View Groups.</p> <p>4.1.2 Understanding Android XML Layout Files: Structure and usage of XML for defining UIs.</p> <p>4.2 Commonly Used UI Components</p> <p>4.2.1 Text Views and Edit Texts: Displaying and editing text.</p> <p>4.2.2 Buttons and Image Buttons: Handling clicks and actions.</p> <p>4.2.3 Image Views: Displaying images.</p> <p>4.3 Advanced UI Components</p> <p>4.3.1 RecyclerView: Displaying lists and grids efficiently.</p> <p>4.3.2 Card View: Presenting information in a card format.</p> <p>4.3.3 Navigation View: Implementing navigation drawers.</p> <p>4.4 Menu and Dialogs</p> <p>4.4.1 Menus and Context Menus: Adding options and context menus.</p> <p>4.4.2 Dialogs and Toasts: Displaying alerts, confirmations, and quick messages.</p>	CO-4
<p>TSO 5a. Explain the basics of SQLite database.</p> <p>TSO 5b. Contrast SQLite with other database solutions.</p> <p>TSO 5c. Integrate the database within the user interface of an Android application.</p> <p>TSO 5d. Apply Practical Skills in SQLite Database Integration and Management</p>	<p>Unit-5.0 Design and Implementation of Database-Driven Applications</p> <p>5.1 Introduction to SQLite Database</p> <p>5.1.1 Creating and opening a database,</p> <p>5.1.2 Creating tables</p> <p>5.1.3 Inserting retrieving and deleting data</p> <p>5.1.4 Choosing the Right Database</p> <p>5.1.5 Comparison of SQLite, Room, Firebase Realtime Database, and other NoSQL databases.</p> <p>5.1.6 SQLite Database Integration</p> <p>5.2. Registering Content Providers</p>	CO-5

Major Theory Session Outcomes (TSOs)	Units	Relevant Cos Number(s)
	5.2.1 Using content Providers (Insert, delete, retrieve and update). 5.3 Understanding SQLite: 5.3.1 Basics of SQLite database 5.3.2 Role and integration in Android applications. 5.4 Implementing a Database-Driven Application 5.4.1 Designing the Database Schema: 5.4.2 Integrating the Database with UI 5.4.3 Database Testing	

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2418603B

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1 Explain mobile ecosystems. LSO 1.2 Explain the evolution of mobile technologies and the architectural differences among major mobile operating systems. LSO 1.3 Comprehend the significance of smartphone architecture in application development.	1.	1.1 Research and present the unique features and development environments of iOS and Android. 1.2 Create a timeline charting the evolution from 1G to 5G, highlighting key technological advancements. 1.3 Compare the architectures of Android, iOS, and Windows mobile OS. 1.4 Use software simulation tools to visualize ARM and Intel architectures in smartphones.	CO-1
LSO 2.1. Store user settings using shared preferences for Android App development LSO 2.2. Performing file operation on internal and external storage. LSO 2.3. Implement CRUD operations using SQLite for mobile app development. LSO 2.4. Share data in different Android applications.	2.	2.1 Develop a simple Android app utilizing Shared Preferences to store user settings. 2.2 Create an app that performs file creation, reading, and writing operations on both internal and external storage. 2.3 Build a basic app that demonstrates CRUD operations using SQLite. 2.4 Develop an app that uses a custom Content Provider for data sharing between two different applications.	CO-2
LSO 3.1. Create Android activities. LSO 3.2. Use views and resources effectively. LSO 3.3. Manipulate the Android Manifest file to configure application settings and permissions.	3.	1.1 Create an app that logs and displays each callback of the Activity lifecycle. 1.2 Create an app that uses a List View to display a list of items and includes at least one custom view. 1.3 Develop an app that dynamically utilizes different types of resources like strings, images, and animations.	CO-3

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
		1.4 Modify the Android Manifest file to change app permissions, define activities, and set the application's theme.	
<p><i>LSO 4.1.</i> Customize of Android UI components</p> <p><i>LSO 4.2.</i> Use advanced elements like Recycler View and Navigation View in their applications.</p>	4.	<p>1.1 Create an app showcasing the use of Text Views, Buttons, and Image Views with various styles and actions.</p> <p>1.2 Develop an app that uses Recycler View to display a list of items efficiently.</p> <p>1.3 Implement an app that uses menus, context menus, and dialogs to interact with the user.</p> <p>1.4 Build an app with a Navigation View that implements a sliding navigation menu.</p>	CO-4
<p><i>LSO 5.1.</i> Integrate databases within Android applications.</p> <p><i>LSO 5.2.</i> Utilize SQLite and Content Providers for robust data management.</p> <p><i>LSO 5.3.</i> Establish seamless interaction between the database and the user interface.</p>	5.	<p>1.1 Develop an app that creates an SQLite database, performs CRUD operations, and displays the data.</p> <p>1.2 Build an app that shares data with another app using a custom Content Provider.</p> <p>1.3 Design and implement a complex database schema within an app, demonstrating normalization and indexing.</p> <p>1.4 Create an app that integrates database operations with the user interface, displaying database content dynamically in the app.</p>	CO-5

Note: in addition to above listed practical, students are suggested to practice all the examples covered by the teacher during theory sessions.

L) Suggested Term Work and Self Learning: S2418603B

- a. **Assignments:** Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.
- b. **Micro Projects:**
 1. Develop a personal finance tracking app that allows users to record their income and expenses. The app should use SQLite for data persistence, allowing users to add, view, edit, and delete financial records. Implement charts or graphs using external libraries to visualize spending patterns over time.
 2. Create a custom contacts application that allows users to save and manage their contacts independently of the phone's default contacts app. Use a custom Content Provider to handle data storage, and implement features for adding, viewing, updating, and deleting contacts.
 3. Build a simple fitness tracking app that allows users to log workouts, track progress, and set goals. Use various Android views and resources to create an interactive and user-friendly interface, including custom views for visualizing workout data.
 4. Develop a local tourist guide app that provides information about tourist attractions, restaurants, and hotels in a selected area. The app should use the mobile device's GPS to offer personalized recommendations. Implement client-server architecture to fetch data from a server and cache it locally for offline access.

J) Theory Session Outcomes (TSOs) and Units:T2400604B

Major Theory Session Outcomes (TSOs)	Units	Relevant Cos Number (s)
<p>TSO 1a. Describe the basic terminology of Machine learning</p> <p>TSO 1b. Explain the concept of dataset and ways to handle them</p> <p>TSO 1c. illustrate the process of dataset division</p> <p>TSO 1d. Explain process involved in machine learning</p>	<p>Unit – 1.0: Introduction to Machine Learning</p> <p>Concept of Machine Learning, Define Learning, Learn the Network, Evaluate the Network, datasets and ways to handle them, Feature sets, Dataset division: test, train and validation sets, cross validation. Applications of Machine Learning, processes involved in Machine Learning</p>	CO-1
<p>TSO 2a. Identify the category or class of a particular dataset using KNN algorithm</p> <p>TSO 2b. Use Linear regression for predictive analysis</p> <p>TSO 2c. Predict the categorical dependent variable using Logistic Regression</p> <p>TSO 2d. Use SVM for classification problems in Machine Learning</p> <p>TSO 2e. determine the performance of the classification models</p> <p>TSO 2f. evaluate the performance of the classification model using ROC-curve</p> <p>TSO 2g Explain characteristics of Unsupervised learning.</p> <p>TSO 2h. Explain different clustering methods</p> <p>TSO 2i. Implement K-means clustering algorithm to group the unlabeled dataset</p>	<p>Unit 2.0: Supervised and Unsupervised Learning</p> <p>Supervised Learning: Introduction to Supervised Learning, K-Nearest Neighbor, Linear Regression, Logistic Regression, Support Vector Machine (SVM), Evaluation Measures: confusion matrix, precision, precision and recall, ROC-Curve (Receiver Operating Characteristic curve)</p> <p>Unsupervised Learning: Introduction to Unsupervised Learning, Introduction to clustering, Types of Clustering: Hierarchical, Agglomerative Clustering and Divisive clustering; Partitional Clustering - K-means clustering. Expectation-Maximization (EM) Algorithm</p>	CO-2
<p>TSO 3a. Explain Structure and working of Biological Neural Network.</p> <p>TSO 3b. differentiate between Artificial Neural Network and Biological Neural Network</p> <p>TSO 3c. State key historical points in development of ANN</p> <p>TSO 3d. Explain the architecture of an artificial neural network</p>	<p>Unit 3.0: Introduction to Neural Networks</p> <p>Structure and working of Biological Neural Network, Fundamentals of Artificial Neural Networks & Applications, Characteristics of Artificial Neural Networks, History of neural network research, characteristics of neural networks terminology.</p>	CO-3
<p>TSO 4a. Use neuron McCulloch – Pitts model in designing logical operations</p> <p>TSO 4b. Apply Rosenblatt's Perceptron to solve linear classification problems</p> <p>TSO 4c. Implement Adaptive Linear Neuron (Adaline) training algorithm in neural network</p> <p>TSO 4d. Use Backpropagation neural training algorithm</p> <p>TSO 4e. Use ART (Adaptive Resonance Theory) learning model</p> <p>TSO 4f: Implement Bidirectional Associative Memory (BAM) model in Artificial Neural Network</p>	<p>Unit 4.0: Neural Networks Models and Learning Methods</p> <p>Models of neuron McCulloch – Pitts model, Rosenblatt's Perceptron, Adaline model, Basic learning laws, Topology of neural network architecture, Multilayer Neural Networks, Learning Methods, Backpropagation, Counter propagation, Adaptive Resonance Theory (ART), Associative memories, BAM.</p>	CO-4
<p>TSO 5a. Illustrate the features of Tens or flow</p> <p>TSO 5b. Manipulate tensors</p> <p>TSO 5c. Explain features of Tens or Board visualization</p> <p>TSO 5d Explain the concept and features of Tens or</p>	<p>Unit-5.0: Tensor flow</p> <p>features of TensorFlow, Tensor Data structure- Rank, shape, type, one dimension and two-dimension tensor, Tensor handling</p>	CO-5

Major Theory Session Outcomes (TSOs)	Units	Relevant Cos Number (s)
flow playground	and manipulations, Tensor board visualization- symbols Tensors, Variables, Automatic differentiation, Graphs and function, modules layers and models, training loops, features of Tens or flow playground- data ,the ration of train and test data, features, hidden layers, Epoch, learning rate, activation function, regularization, problem type	

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical:P2400604B

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1 Implement data classification algorithms	1	Write a program to implement k-Nearest Neighbor algorithm to classify the iris data set. Print both correct and wrong predictions. Python ML library classes can be used for this problem.	CO-2
LSO 2.1 Implement Machine learning algorithms LSO 2.2 Evaluate the performance of classification model	2	(a) Implement SVM for Iris Dataset- download the dataset from (https://gist.github.com/netj/8836201) (b) Find confusion matrix and evaluation matrix for SVM Hint: SVM model can be constructed using sklearn command, import pandas as pd from sklearn.svm import SVC from sklearn.model_selection import train_test_split from sklearn.metrics import confusion_matrix from sklearn.metrics import classification_report from sklearn.metrics import accuracy_score 1. Read the csv Iris dataset file 2. Condition the data 3. Condition the training and Testing data 4. Construct the Linear model 5. Test the model with Linear kernel 6. Prepare confusion matrix 7. prepare Classification Report	CO-2
LSO 3.1 Perform clustering operations using k-means algorithm	3	a) Explore k-means algorithm for the small sample dataset. b) Explore k-means algorithm for Iris Dataset	CO-2
LSO 4.1 Perform clustering operations using EM algorithm	4	Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Python ML library classes/API in the program.	CO-2
LSO 5.1 Build artificial neural network LSO 5.2 Test artificial neural network	5	Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.	CO-4

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 6.1 Detect features or business intelligence in the input data using perceptron	6	Implement the perceptron algorithm from scratch in python.	CO-4
LSO 7.1 Use Tensors for given problems	7	Write a programme to implement two dimension and three-dimension Tensor.	CO5
LSO 8.1 Use basic features for tensor handling and manipulations	8	Write a programme to add and multiply two 4x4 matrix, you can Import "tens or flow" and "numpy".	CO5
LSO 9.1 Test artificial intelligence (AI) algorithms through the use of Google's TensorFlow machine learning libraries.	9	Solve a classification problem on the Tens or flow playground. Hint: refer https://www.educba.com/tensorflow-playground/	CO5
LSO 10.1 Implement artificial intelligence (AI) algorithms through the use of Google's TensorFlow machine learning libraries LSO 10.2 perform predictive analysis using linear regression	10	Implement algorithm for linear regression in tens or flow	CO5, CO2

L) **Suggested Term Work and Self Learning:S2400604B** Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. **Assignments:** Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. **Micro Projects:**

Use python programming for the solutions of Microproject problems

- Create a Bar plot to get the frequency of the three species of the Iris data.
 - Create a Pie plot to get the frequency of the three species of the Iris data.
 - Write a Python program to create a graph to find relationship between the sepal length and width.
- Write a Python program to split the iris dataset into its attributes (X) and labels (y). The X variable contains the first four columns (i.e. attributes) and y contains the labels of the dataset.
 - Write a Python program using Scikit-learn to split the iris dataset into 70% train data and 30% test data. Out of total 150 records, the training set will contain 120 records and the test set contains 30 of those records. Print both datasets.
- Conduct performance analysis of Classification Algorithms (any 2) on a specific dataset.

M) **Suggested Course Evaluation Matrix:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be assessed to calculate CO attainment.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment(ETA)	Term Work & Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	20%	15%	30%	20%	30%	--	--

- Legend:**
- CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)
- LI: Laboratory Instruction (Includes experiments/practical performances/ problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)
- Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.
- TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)
- SL: Self Learning, MOOCS, spoken tutorials, Online educational resources etc.
- C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)
- Note:** TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400604C	IoT Advanced)	30	70	20	30	20	30	200

- Legend:**
- PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)
- PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)
- TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.)

- Note:**
- ETA & ELA are to be carried out at the end of the term/ semester.
 - Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

- I) Course Curriculum Detailing:** This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units:T2400604C

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.1. a. Write the steps to install Python. TSO.1. b. Explain given types of variables in python. TSO.1. c. Explain use and importance of Tuple, Dictionary, operators in python TSO.1. d. Explain use of array in python.	Unit-1.0 Python Basics: - 1.1 Installation of Python 1.2 Variables, Print () function, Escape character sequence and run python Program	CO-1 and CO-5

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.1. e. Explain use of 2-Dimensional Array in python TSO.1. f Explain uses of given type of Conditional statement in python.	1.3 Python Tuple, Dictionary, operators 1.4 Python arrays, create, reverse and append data into it. 1.5 Python 2 Dimensional arrays. 1.6 Python Conditional statement.	
TSO.2. a. Explain uses of given type of do & while loops in python TSO.2. b. Explain working of break, continue and pass statement in python TSO.2. c. Write the benefits of using OOP methodology in python. TSO.2. d. Explain given type of string operation related to python. TSO.2. e. Explain given function in python TSO.2. f Explain use of Lambda function in python.	Unit 2.0 Python Advance: - 2.1 Python Do & while loops 2.2 Python break, continue, pass statements 2.3 Python OOPs Class, Object, Inheritance and Constructor 2.4 Python Strings Replace, Join, Split, Reverse, Uppercase, Lowercase, count, find, split and length 2.5 Python Functions, Built-in functions and user defined functions 2.6 Lambda function and uses	CO-1 and CO5
TSO.3. a. Differentiate between Cloud and IoT cloud. TSO.3. b. Explain features of Cloud in IoT environment TSO.3. c. List features of various types of Cloud TSO.3. d. List features of cloud services like SaaS, PaaS and IaaS TSO.3. f List advantages of cloud data storage. TSO.3. g Explain Arduino architecture and its applications. TSO.3.h Explain Raspberry pi architecture and its applications.	Unit-3.0 Cloud Features: - 3.1 Cloud computing and IoT cloud 3.2 Benefits of cloud in IoT 3.3 Types of Cloud public, private and hybrid 3.4 Cloud services like SaaS, PaaS and IaaS 3.5 Cloud connectivity and Data storage on Cloud. 3.6 Arduino: Architecture, Programming, and Applications 3.7 Raspberry Pi Architecture, Programming, and Application basic level for IoT applications	CO-1, CO-2 and CO-5
TSO.4. a. Explain wired network TSO.4. b. Explain short range wireless network TSO.4. c. Explain M2M communication TSO.4. d. Explain various generation of wireless network TSO.4. e. Explain the importance of LWPAN in IoT TSO.4. f Differentiate between SigFox & LoRaWAN TSO.4. g Explain use of NB-IOT (Narrow Band IOT) TSO.4.h Create heterogenous network using RFID.	Unit.4.0 IoT Networking and Application: - 4.1 Wired and short-range wireless network 4.2 M2M – 2G, 3G, 4G & 5G networks 4.3 LPWAN – Low Power Wide Area Networks 4.4 SigFox & LoRaWAN. 4.5 NB-IOT (Narrow Band IOT) 4.6 RFID and Bar code basics- Components of an RFID system-Data -Tags-Antennas- Connectors- Cables- Readers- encoder/ printers for smart labels- Controllers software 4.7 RFID advantages over Bar codes.	CO-1 and CO-4
TSO.5. a. Identify suitable framework for IoT app development TSO.5. b. Identify various stages of selected app TSO.5. c. Develop the app. TSO.5. d. Implement and deploy the app TSO.5. e Maintain and improve the app based on the feedback	Unit. 5.0 IoT App Development: - 5.1 Framework selection for IoT app development 5.2 Identify stages of app to be developed. 5.3 Develop, Implement, and Deploy the App 5.4 Testing and Integration 5.5 Maintain and improve	CO-4 and CO-5

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical:P2400604C

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1 Python installation LSO 1.2 Prepare and run python program on given problem LSO 1.3 Prepare python program on Dictionary, Tuple and operators. LSO 1.4 Prepare program on arrays LSO 1.5 Prepare a program on 2-dimensional array LSO 1.6 Create program on conditional statement	1.	1.1 Install given version of Python on the computer system. 1.2 Prepare a python program using print() function and run it. 1.3 Access given value from the tuple 1.4 Print the given value of key from the dict. 1.5 Write a Python program to create an array of 5 integers and display the array items. Access individual element through indexes 1.6 Write a Python program which takes two digits m (row) and n (column) as input and generates a two-dimensional array. 1.7 Write a python program to check whether person is eligible for voting or not. (accept age from the user) 1.8 Write a python program to check whether the entered number is even or odd. 1.9 Write a python program to check whether entered number is divisible by another entered number. 1.10 Write a python program to display "Yes" is entered number is divisible by 5 otherwise display "No"	CO-1
LSO 2.1 Prepare python program on Do & while loops LSO 2.2 Prepare python program on break and continue statement. LSO 2.3 Prepare Python program using break and continue statements LSO 2.4 prepare python program using OOP LSO 2.5 Prepare Python program using functions	2.	2.1 Prepare a python program which can print first 10 even and odd numbers using while statement 2.2 Write a python program which can print first 10 integers and its square using while/for loop. 2.3 Write a python program which can print sum of first 10 natural numbers using while/for loop. 2.4 Write a python program which can identify the prime number between the range given using while/for loop. 2.5 Consider a situation where you want to iterate over a string and want to print all the characters until a letter 'e' or 's' is encountered. It is specified that you have to do this using loop and only one loop is allowed to use. 2.6 Consider the situation when you need to write a program which prints the number from 1 to 10 and but not 6. It is specified that you have to do this using loop and only one loop is allowed to use. 2.7 Create a Class with instance attributes 2.8 Create a Vehicle class without any variables and methods 2.9 Write a Python function to find the Max of three numbers. 2.10 Write a Python program to reverse a string.	CO-2
LSO 3.1 Signup for free cloud storage	3.	3.1 Create a free cloud account 3.2 Store data on cloud and retrieve it	CO-3

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 3.2 Store data into cloud and retrieve it.			
LSO 4.1 Design various types of network cables LSO 4.2 Connect computer in LAN. LSO 4.3 Connect devices using wireless network LSO 4.4 Connect machine with machine LSO 4.5 Connect devices using IEEE 802 LSO 4.6 Connect devices using LPWAN LSO 4.7 Connect devices using RFID	4	4.1 Study of different types of Network cables and Practically implement the cross-wired cable and straight through cable using clamping tool. 4.2 Connect the computers in Local Area Network 4.3 Connect 2 or more devices using Bluetooth 4.4 Connect 2 or more devices using infrared 4.5 Connect 2 more machine using m2m 4.6 Connect 2 or more different devices using access point 4.7 Connect 2 devices using LPWAN (Smart Meter) 4.8 Connect 2 or more devices using RFID	CO-4
LSO 5.1 Develop a IoT app LSO 5.2 Develop IoT applications using smartphones.	5.	5.1 Identify a problem and develop an app 5.2 Building a temperature monitoring system using sensors and Smartphone	CO-5

L) **Suggested Term Work and Self Learning: S2400604C** Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. **Assignments:** Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. **Micro Projects:**

1. Prepare a report on Python programming language.
2. Develop a small software in python to solve a IoT data analysis.
3. Create a id on free cloud storage and share data on it for others.
4. Create a heterogenous network and connect different dives.
5. Create a an IoT app for the identified problem

c. **Other Activities:**

1. Seminar Topics: - "Future of wireless network."
2. "Smart electricity billing ", "Cloud computing and IoT"
3. Visit to industry for IoT implementation in industrial process.
4. Reading RFID cards using 8051- RFID in the supply chain- Vehicles parking using RFID- library management system- electronic toll payment- smart shipping containers fleet monitoring and management.
5. Building IoT Applications like pressure, air quality, temperature and motion detector using Arduino and raspberry-pi Universal boards.
6. Surveys of market for availability of various types of network devices and its pricing.
7. Product Development: Development of projects for real life problem solution app.
8. Software Development: Using Python

d. **Self-Learning Topics:**

1. Deeper knowledge in Python features
2. Network devices and its capabilities
3. Advantages of IoT implementations

Legend:

- CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)
- LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)
- Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.
- TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)
- SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.
- C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)
- Note:** TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400604D	Drone Technology (Advanced)	30	70	20	30	20	30	200

Legend:

- PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)
- PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)
- TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.)

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units:T2400604D

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
TSO 1a. Draw free body diagram of quadcopter drone.	Unit-1.0 Engineering mechanics for Drone Technology 1.1 Drone Mechanics <ul style="list-style-type: none"> Free body diagram of drone Method of finding resultant of force system 	CO-1
TSO 1b. Determine centroid of given drone structure.		

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
TSO 1c. Determine center of gravity of different drone structure. TSO 1d. Analyze different types of force acting drone system. TSO 1e. Differentiate between static and dynamic force analysis. TSO 1f. Explain how gyroscopic motion keeps drone balanced and hovering.	<ul style="list-style-type: none"> • Equilibrium of coplanar force system 1.2 Center of Gravity <ul style="list-style-type: none"> • Centroid of plane figure • Center of gravity of solid bodies 1.3 Force analysis in drone <ul style="list-style-type: none"> • Force analysis in drone • Forces of flight • Principle axes and rotation of aerial systems 1.4 Dynamics of machine <ul style="list-style-type: none"> • Static and dynamic force analysis • Gyroscopic motions 	
TSO 2a. Describe properties and application of smart materials use in UAV frame. TSO 2b. Calculate the diameter of the propeller for given drone frame size. TSO 2c. Determine size of quadcopter frame and diameter of propeller of drone TSO 2d. Describe working of GPS and its hardware interfacing. TSO 2e. Write steps to interface GPS module for drone navigation. TSO 2f. Describe different RF blocks and antennas used in RF transmitter and receiver.	Unit-2.0 Drone Frame and Components 2.1 Drone frame design <ul style="list-style-type: none"> • Calculation principle for drome frame sizes • Quadcopter frame design • Smart materials for UAV frame Green material uses in drone 2.2 Advance Drones component <ul style="list-style-type: none"> • GPS, Interfacing of GPS hardware • Thermal and chemical sensor • Tilt and LiDAR sensor 2.3 RF transmitter and receiver <ul style="list-style-type: none"> • RF blocks • RF antennas 2.4 Micro-electromechanical systems (MEMS) based sensor 2.5 HD and thermal Image camera	CO-2
TSO 3a. Identify features and specifications of FCB use in different application TSO 3b. Explain ports of any given advance flight controller board. TSO 3c. Write steps of software installation of flight controller board. TSO 3d. Describe installation and calibration steps of radio telemetry with FCB. TSO 3e. Write steps of calibration of accelerometer and ESC with FCB. TSO 3f. Describe interfacing of GPS with FCB.	Unit-3.0 Advance flight controller Board (FCB) 3.1 Specification and ports of FCB 3.2 Software for FCB <ul style="list-style-type: none"> • Software installation 3.3 Radio Communication with FCB <ul style="list-style-type: none"> • Installation of Radio Telemetry • Radio Calibration with FCB 3.4 Calibration of accelerometer 3.5 Calibration of ESC 3.6 Interface of motor with FCB using ESC 3.7 GPS interface with FCB 3.8 Safety features of advance FCB	CO-3
TSO 4a. Describe challenges comes in drone maintenance.	Unit-4.0 Maintenance and Assembling of Drone 4.1 Need and scope of drone maintenance 4.2 Types of maintenance	CO-4

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
<p>TSO 4b. Describe measuring devices and instrument use in drone maintenance.</p> <p>TSO 4c. Describe measuring instrument used to measure electrical parameters in drone.</p> <p>TSO 4d. Write sequence of steps use in assembling of drone.</p>	<p>4.3 Routine drone maintenance and its checklist</p> <ul style="list-style-type: none"> Recording basic details Structural inspection Battery check Software/firmware <p>4.4 Types of measuring instrument use in drone maintenance</p> <p>4.5 Measurement of different electrical parameters related with drone hardware</p> <p>4.6 Assembly of drones</p> <ul style="list-style-type: none"> Concept of interchangeability Principle of gauging and their applicability in drone assembly Parameters and profile measurements of standard propellers Concepts of drone assembly using 3D modeling 	
<p>TSO 5a. Describe function of autonomous drone using AI.</p> <p>TSO 5b. Describe IoT enable UAV for surveillance and data gathering.</p> <p>TSO 5c. Explain drone applications based on cost saving, enhanced efficiency and profitability aspects.</p>	<p>Unit-5.0 Advance Drone Application</p> <p>5.1 Application of AI in Drone Technology</p> <p>5.2 IoT and Computer vision integrated Drone</p> <p>5.3 Drone interface with smart-phone</p> <p>5.4 Drone Applications in</p> <ul style="list-style-type: none"> Military Precision Agriculture 	CO-5

Note: One major TSO may require more than one theory session/period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400604D

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1 Use the force of gravity to compute the centre of gravity for a given drone structure.	1.	Determine Centre of gravity of different drone structure.	CO-1
LSO 2.1 Develop skills of observation and interpreting phenomenal changes on Drone model for stability and hovering.	2.	Demonstrate gyroscopic effect on a drone model	CO-1
<p>LSO 3.1 Draw various frame to be required in designing drone structure.</p> <p>LSO 3.2 Use Measuring instrument in designing drone frame.</p> <p>LSO 3.3 Choose suitable materials for making drone frame</p>	3.	Compare different types of airframe structure like quadcopter frame (plus shape, cross shape and H-shape), hexacopter frame (hexa + and hexa S).	CO-2, CO-4
<p>LSO 4.1 Identify and measure the condition of sensors.</p> <p>LSO 4.2 Interface Tilt and LiDAR sensors in drone.</p>	4.	Test Tilt and LiDAR sensors and their characteristics with Microcontroller based Flight controller board.	CO-2
<p>LSO 5.1 Identify different component of GPS module</p> <p>LSO 5.2 Measure and use signals from GPS module to determine latitude & longitude.</p> <p>LSO 5.3 Diagnose problems using appropriate instruments/tools related to GPS navigation.</p>	5.	Demonstrate the interfacing of GPS module to drone navigation.	CO-2, CO-3

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 6.1 Measure characteristics of HD and thermal Image camera. LSO 6.2 Diagnose common problems related to HD and thermal Image camera.	6.	Test HD and thermal Image camera and their characteristics.	CO-2
LSO 7.1 Identify the characteristics of RF circuit blocks like amplifier, and filters. LSO 7.2 Identity different antennas used. LSO 7.3 Operate drone using RC transmitter and receiver.	7.	Identify, configure and operate 433MHz and 2.4 GHz RC transmitter and receiver.	CO-2
LSO 8.1 Test the different peripheral interconnections with FCB LSO 8.2 Troubleshoot advance Flight control board (FCB)	8.	Programming and configure of parameters in flight control board (FCB).	CO-3
LSO 9.1 Configure radio communication device to control drones. LSO 9.2 Operate drone using RC transmitter and receiver.	9.	Test and perform communication of advance Flight control board with RF transceiver.	CO-3, CO-2
LSO 10.1 Measure various parameters of GPS system LSO 10.2 Interface GPS system with flight controller board.	10.	Test and perform communication of Flight control board (FCB) with GPS	CO-3, CO-2
LSO 11.1 Configure HD and thermal image camera with drone. LSO 11.2 Demonstrate use of HD and thermal image camera with FCB	11.	Test and troubleshoot HD and thermal image camera with advance FCB in drone.	CO-3, CO-2
LSO 12.1 Measure voltage, current frequency using Digital Multimeter LSO 12.2 Measure peak to peak voltage, time period, and duty cycle using DSO and waveform generator. LSO 12.3 Measure unknown frequency and its level using spectrum analyzer.	12.	Measure various electric parameters in drone hardware	CO-4
LSO 13.1 Inspect drone as per the given checklist LSO 13.2 Diagnose drone problems after flying of 50 and 100hrs	13.	Perform preventive maintenance of drone components	CO-4
LSO 14.1 Perform dismantle process of drone. LSO 14.2 perform services need for operation LSO 14.3 Check and Install different parts of the drone system. LSO 14.4 Assemble drone component.	14.	Dismantle and service of different parts of drone system	CO-4

L) **Suggested Term Work and Self Learning: S2400604D** Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. **Assignments:** Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. **Micro Projects:**

1. Prepare maintenance report for small UAV.
2. Survey nearby electronics shop and Prepare report on types of drone frames and drone sensors available and its specification.
3. Prepare report of surveying & mapping of our institute using drone with HD and thermal image camera.
4. Prepare report on land and crops quality of nearby agriculture field using drone.

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400604E	3D Printing and Design (Advanced)	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.)

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self-Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units:T2400604E

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain various forms of 3D printing raw material.	Unit-1.0 3D Printing Materials	CO1
TSO 1b. Select material for the given popular 3D printing processes with justification.	1.1 Various forms of 3D printing raw material- Liquid, Solid, Wire, Powder.	

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1c.</i> Select various Polymer based 3D printing raw materials with justification.</p> <p><i>TSO 1d.</i> Explain procedure of Powder preparation for the given 3D printing material.</p> <p><i>TSO 1e.</i> Explain properties of the given Metal/Ceramics 3D printing material.</p> <p><i>TSO 1f.</i> Choose suitable 3D printing material on the basis of Performance Requirements and Material Properties.</p>	<p>1.2 Popular FDM, SLA, SLS, Binder Jetting, Material Jetting and Direct Energy deposition 3D printing materials.</p> <p>1.3 Polymers, Metals, Non-Metals, Ceramics.</p> <p>1.4 Polymers and their properties.</p> <p>1.5 Powder Preparation and their desired properties.</p> <p>1.6 Choosing the Right 3D Printing Material on the basis of Performance Requirements and Material Properties.</p>	
<p><i>TSO 2a.</i> Explain working of a typical FDM based 3D Printer.</p> <p><i>TSO 2b.</i> Justify use of FDM based 3D printing process and material for the given component.</p> <p><i>TSO 2c.</i> Explain the Laminated Object Manufacturing process.</p> <p><i>TSO 2d.</i> Estimate the cost and time of the given FDM based 3D printed component.</p>	<p>Unit-2.0 Solid based 3D Printing Processes</p> <p>2.1 Basic principle and working of fused deposition modeling (FDM) process.</p> <p>2.2 Liquefaction, solidification and bonding.</p> <p>2.3 Laminated Object Manufacturing process.</p> <p>2.4 Cost estimation of FDM 3D printed component.</p>	CO1, CO2
<p><i>TSO 3a.</i> Explain the phenomenon of Photo Polymerization.</p> <p><i>TSO 3b.</i> Explain the working of a typical Stereo Lithography based 3D Printer.</p> <p><i>TSO 3c.</i> Explain procedure of 3D Scanning of the given component.</p> <p><i>TSO 3d.</i> Justify use of SLA based 3D printing process and material for the given component.</p> <p><i>TSO 3e.</i> Estimate the cost and time of the given SLA based 3D printed component.</p> <p><i>TSO 3f.</i> Apply Curing process to SLA based 3D printed component.</p>	<p>Unit-3.0 Liquid based 3D Printing Processes</p> <p>3.1 Photo polymerization.</p> <p>3.2 Principle and working of stereo lithography apparatus.</p> <p>3.3 SLA based 3D printing processes.</p> <p>3.4 SLA based 3D printing process materials.</p> <p>3.5 Scanning techniques.</p> <p>3.6 Curing processes.</p> <p>3.7 Cost estimation of SLA 3D printed component.</p>	CO1, CO3
<p><i>TSO 4a.</i> Explain powder fusion mechanism.</p> <p><i>TSO 4b.</i> Explain working of a typical SLA based 3D Printer.</p> <p><i>TSO 4c.</i> Justify use of SLA based 3D printing process and material for the given component.</p> <p><i>TSO 4d.</i> Explain Net shape process.</p> <p><i>TSO 4e.</i> Explain Binder Jet 3D printing process.</p> <p><i>TSO 4f.</i> Justify use of Binder Jet 3D printing process and material for the given component.</p> <p><i>TSO 4g.</i> Estimate the cost and time of the given SLS based 3D printed component.</p>	<p>Unit-4.0 Powder based 3D Printing Processes</p> <p>4.1 Powder fusion mechanism.</p> <p>4.2 Principle and working of Selective Laser Sintering (SLS) process.</p> <p>4.3 SLS based 3D printers.</p> <p>4.4 Laser Engineering Net Shaping process.</p> <p>4.5 Electron Beam Melting.</p> <p>4.6 Binder Jet 3D Printing.</p> <p>4.7 Materials and Process parameters for SLS based 3D printing processes.</p> <p>4.8 Cost estimation of SLS based 3D printed component.</p>	CO1, CO4
<p><i>TSO 5a.</i> Justify the need of post processing in the given 3D printed component.</p> <p><i>TSO 5b.</i> List the various post processing techniques.</p> <p><i>TSO 5c.</i> List the steps to perform post processing.</p>	<p>Unit-5.0 Post Processing and Quality</p> <p>5.1 Need of post processing: Functional and Aesthetic reasons.</p> <p>5.2 Steps of Post Processing: Cleaning/Support removal, Fixing, Curing or hardening, Surface finishing, Colouring.</p>	CO1, CO2, CO3, CO4, CO5

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 5d.</i> Explain the given Cleaning related post processing approach for 3D printed component.</p> <p><i>TSO 5e.</i> Explain the given Surface finishing related post processing approach for 3D printed component.</p> <p><i>TSO 5f.</i> Apply simple inspection and testing techniques on the given 3D printed component.</p> <p><i>TSO 5g.</i> Identify the type of defect(s) in the given 3D printed component.</p>	<p>5.3 Cleaning: Support Removal (FDM and Material Jetting); Powder Removal (SLS and Powder Bed Fusion); Washing (SLA and Photo polymerization).</p> <p>5.4 Fixing: Filling, Gluing, Welding.</p> <p>5.5 Surface finishing: Sanding, Polishing, Tumbling, Hydro dipping, Epoxy coating, Electro Plating, Vapor Smoothing-Acetone treatment.</p> <p>5.6 Colorings, Coating, Priming and Painting.</p> <p>5.7 Inspection and testing: Digital, Visual, Physical.</p> <p>5.8 Defects and their causes.</p>	

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical:P2400604E

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<p><i>LSO 1.1.</i> Use the available 3D printing software.</p> <p><i>LSO 1.2.</i> Select printing process parameters based on the type/make of Printer and raw material</p> <p><i>LSO 1.3.</i> Set printing process parameters.</p> <p><i>LSO 1.4.</i> Produce a complex component using available FDM Printer.</p>	1.	Develop the assigned digital single complex component using FDM based 3D Printer and available material.	CO1, CO2
<p><i>LSO 2.1.</i> Use the available 3D printing software.</p> <p><i>LSO 2.2.</i> Select printing process parameters based on the type/make of Printer and raw material</p> <p><i>LSO 2.3.</i> Set printing process parameters.</p> <p><i>LSO 2.4.</i> Produce a complex component using available SLA Printer.</p> <p><i>LSO 2.5.</i> Perform curing of the SLA based 3D printed component.</p>	2.	Develop the assigned digital single complex component using SLA based 3D Printer and available material.	CO1, CO3
<p><i>LSO 3.1.</i> Use the available 3D printing software.</p> <p><i>LSO 3.2.</i> Select printing process parameters based on the type/make of Printer and raw material</p> <p><i>LSO 3.3.</i> Set printing process parameters.</p> <p><i>LSO 3.4.</i> Produce a complex component using available SLS Printer.</p>	3.	Develop the assigned digital single complex component using SLS based 3D Printer and available material.	CO1, CO4
<p><i>LSO 4.1.</i> Use the available 3D printing software.</p> <p><i>LSO 4.2.</i> Select printing process parameters based on the type/make of Printer and raw material</p> <p><i>LSO 4.3.</i> Set printing process parameters.</p> <p><i>LSO 4.4.</i> Produce a complex component using available FDM, SLA and SLS Printer.</p>	4.	Develop same digital single complex component using FDM, SLA and SLS based 3D Printers and compare the printed components on the basis of Cost, Time, Surface finish, Strength.	CO1, CO2, CO3, CO4

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<i>LSO 4.5.</i> Perform Cost, Time, Surface finish and Strength estimations related to 3D printed components.			
<i>LSO 5.1.</i> Use the available 3D printing software. <i>LSO 5.2.</i> Select printing process parameters based on the type/make of Printer and raw material <i>LSO 5.3.</i> Select appropriate tolerance, fit and printing process parameters. <i>LSO 5.4.</i> Produce an assembly using available SLA/SLS Printer.	5.	Print one digital assembly on SLA/SLS based 3D Printer.	CO2/CO3/ CO4
<i>LSO 6.1.</i> Use of available 3D scanner. <i>LSO 6.2.</i> Develop 3D digital model using scanning approach. <i>LSO 6.3.</i> Use the available 3D printing software. <i>LSO 6.4.</i> Produce a complex component using available SLA Printer.	6.	Scan the given real complex component and print it using FDM/SLA/SLS based 3D Printer.	CO2, CO3, CO4
<i>LSO 7.1.</i> Identify tools/devices/chemicals for post processing <i>LSO 7.2.</i> Perform post processing operations on printed component.	7.	Apply post processing techniques on the 3D printed component of experiment number 1 and/or 2 and/or 3.	CO5
<i>LSO 8.1.</i> Identify tools/devices/techniques for inspection and testing. <i>LSO 8.2.</i> Identify the defects in 3D printed components <i>LSO 8.3.</i> Apply remedial measures to bring soundness in the defective 3D printed component.	8.	Check the soundness of the 3D printed component of experiment number 1 and/or 2 and/or 3 using available devices/techniques.	CO5

L) **Suggested Term Work and Self Learning: S2400604E** Some sample suggested assignments, micro project and other activities are mentioned here for reference

a. **Assignments:** Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. **Micro Projects:**

1. Prepare a list of solid, liquid and powder form 3D printing raw materials stating their cost, colour opacity, flexibility and weight per unit volume.
2. Download 5 videos of 3D printing of different components using FDM, SLA and SLS each. Watch them and write a report to detail out the steps involved, 3D Printer used, 3D Printing software used, material used, complexity involved, printing time, post processing steps used.
3. Prepare a report on post processing steps and techniques used for 3D printed components using FDM, SLA, SLS.
4. Prepare a report to compare FDM, SLA, SLS based 3D printing process on the basis of cost, surface finish, printer setting time, printing time and post processing time and cost involved.

J) Theory Session Outcomes (TSOs) and Units: T2400604F

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p>TSO.1a Describe how does a PLC communicate?</p> <p>TSO.1b Differentiate between parallel and series communication</p> <p>TSO.1c Describe the data transfer mechanism for the given communication protocols.</p> <p>TSO.1d Describe the given communication protocol used in PLC communication.</p> <p>TSO.1e Summarize PLC to PLC communication procedure</p> <p>TSO.1f Describe the common procedure to interface the PLC with other given hardware.</p>	<p>Unit-1.0 Industrial automation communication and Interfacing</p> <p>1.1 Analog and Digital Communications on Plant Floors</p> <p>1.2 Introduction to Industrial Networking</p> <p>1.3 RS232-422-485 standards for data communication</p> <p>1.4 Industrial Ethernet</p> <p>1.5 Concept of Fieldbus</p> <p>1.6 MODBUS protocol</p> <p>1.7 Highway Addressable Remote Transducer (HART) Protocol</p> <p>1.8 Interfacing of Programmable Logic Controller with other hardware</p>	CO-1
<p>TSO.2a Specify the proper I/O addressing format of the given PLC.</p> <p>TSO.2b Explain the use of different relay type instructions for the given operation.</p> <p>TSO.2c Describe how a program is executed with the help of Program Scan cycle</p> <p>TSO.2d Develop ladder logic program using arithmetic functions to perform the given operation.</p> <p>TSO.2e Develop ladder logic programs using logical and comparison instructions to perform the given operation</p> <p>TSO.2f Develop ladder logic programs using on delay, off delay and reset/retentive timer in a given PLC to create a delay in operation.</p> <p>TSO.2g Develop ladder logic programs using Up, Down and UP-down counter in a given PLC to count the number of products</p>	<p>Unit-2.0 PLC Programming</p> <p>2.1 PLC I/O addressing in ladder logic</p> <p>2.2 PLC programming instructions using ladder logic and relay type instructions</p> <p>2.3 Program Scan cycle</p> <p>2.4 PLC arithmetic functions - Addition, subtraction, multiplication, division instructions, increment decrement, trigonometric</p> <p>2.5 PLC logical functions - AND, OR, XOR, NOT functions, PLC compare and convert functions.</p> <p>2.6 Programming Timer –Addressing a timer block, status bits, On delay, Off Delay and reset/retentive timer</p> <p>2.7 Programming Counter- Addressing a counter block, status bits, Up and Down counter, up-down counter, counter examples, register basics</p> <p>2.8 Develop ladder logic for various simple applications</p>	CO-2
<p>TSO.3a Describe Requirements for PLC enclosure.</p> <p>TSO.3b Describe Proper grounding techniques.</p> <p>TSO.3c Describe noise reduction Techniques.</p> <p>TSO.3d Explain preventive maintenance procedure associated with PLC system to reduce environmental impact</p> <p>TSO.3e Identify faults in the given PLC system</p> <p>TSO.3f Explain the procedure for Troubleshooting PLC system</p> <p>TSO.3g Prepare preventive maintenance plan for the PLC system</p> <p>TSO.3h Use safety equipment's.</p> <p>TSO.3i Follow safe practices</p>	<p>Unit-3.0 Installation and maintenance of PLC systems</p> <p>3.1 PLC enclosure, grounding requirements, noise generating inductive devices, leaky inputs and outputs, techniques to reduce electrical noise and leakage.</p> <p>3.2 Introduction to PLC Trouble shooting and maintenance, trouble shooting of hardware and software.</p> <p>3.3 Diagnostic LED Indicators in PLCs</p> <p>3.4 Common problems</p> <ul style="list-style-type: none"> Internal problems – Check for PLC Power Supply, Emergency Push Button, Power Supply Failure, Battery Failure, Electrical Noise Interference, Verify the PLC Program with the Master Program, Corrupted PLC Memory External problems - Power failure, faulty grounding and electrical noise interference (RFI or EMI), Status of the Output Modules and their associated Circuitry, Status of the Input Modules and their associated 	CO-3

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	Circuitry, Field Input and Output Devices, Communication Issues. <ul style="list-style-type: none"> • Environmental Conditions. Check for humidity, temperature, vibration, and noise-level limits specified by its manufacturer 3.5 Troubleshooting of Specific Components of the PLC System <ul style="list-style-type: none"> • Power Supply Troubleshooting • I/O Modules Troubleshooting • Troubleshooting PLC Program Errors • Troubleshooting the Working Environment of a PLC • Replacement of CPU 3.6 PLC trouble shooting flowchart 3.7 PLC maintenance – PLC maintenance checklist, preventive maintenance procedure, maintenance plan for the PLC system. 3.8 Safety procedure and safety equipment's.	
TSO.4.a Describe the function of given element of a SCADA system. TSO.4.b Interface the given PLC with SCADA system using the given Open Platform Communications (OPC). TSO.4.c Describe the steps to develop a simple SCADA screen for the given industrial application. TSO.4.d Describe the procedure to maintain the SCADA based PLC system for the given application.	Unit-4.0 SCADA and DCS 4.1 Introduction, need, benefits and typical applications of SCADA and DCS 4.2 SCADA Architecture - Remote Terminal Units (RTUs), Master Terminal Units, Various SCADA editors, Communication protocols for SCADA 4.3 Comparison of SCADA with DCS 4.4 Interfacing SCADA system with PLC- Typical connection diagram, Object Linking and Embedding for Process Control (OPC) architecture 4.5 Creating SCADA Screen HMI for simple object, Steps for linking SCADA object (defining Tags and items, creating trends etc.,) with PLC ladder program using OPC, configuring simple applications using SCADA: Traffic light control, water distribution, pipeline control, Power generation, transmission and distribution etc. 4.6 Procedure to maintain the SCADA based PLC system.	CO-3
TSO.5a Identify different components used for automation in the given system TSO.5b Select automation components for a given situation TSO.5c In the given manufacturing or service industry Identify the areas where automation is possible. TSO.5d Prepare plan for sustainable automation as per the requirement.	Unit-5.0 Applications of Industrial Automation 5.1 Manufacturing- Industrial Robots- welding robots, pick and place robots, Cabot's, Machine monitoring system, supply chain, Automated assembly system, Flexible Automation and programmable Automation. 5.2 Health Care- microscopic robots for medical diagnosis, automated medication dispensing devices, AESOP, ZEUS, RP_7(remote presence 7th generation), DaVinci 5.3 Defense- guided rockets and missiles, counter measures, UAV drones, launcher, radar antenna, engagement control system 5.4 Automobile –Break monitoring system, Vehicle tracking system, Rear-view alarm to detect obstacles behind, Four-wheel drive, Traction control system, Dynamic steering response, Anti-lock braking system (ABS) Adaptive cruise control, Adaptive headlamps, Intelligent Parking Assist System, Driverless/Autonomous Cars 5.5 Agriculture- harvesters, irrigation systems, plowing machines, self-driving tractors, grain yield sensor 5.6 Mining- Mine planning system, mine picture compilation, mine control system, seismic imagining, laser imaging, Rig control system, automated drilling, automated exploration, automated truck	CO-5

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400604F

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<i>LSO 1.1</i> Data communication from PLC to PC and vice versa	1.	Transfer the control data from PLC to PC and vice versa	CO1
<i>LSO 1.2</i> Establish Communication channels between PLC s.	2.	Transfer the control data from PLC to PLC	CO1
<i>LSO 1.3</i> Transfer data from sensors to PLC and from PLC to PC.	3.	Transfer the sensor data from sensor to PLC to PLC and PC	CO1
<i>LSO 1.4</i> Interface the given PLC with a PC or a Laptop	4.	Interface the given PLC with a PC or a Laptop	CO1
<i>LSO 2.1</i> Identify Different parts and front panel indicators of a PLC	5.	Identify the various parts and front panel status indicators of the given PLC.	CO2
<i>LSO 2.2</i> Develop Ladder logic program for different arithmetic operations	6.	Develop/Execute ladder logic program for different arithmetic operations such as Addition, subtraction, multiplication, division increment, decrement, trigonometric in a given PLC	CO2
<i>LSO 2.3</i> Develop Ladder logic program for different logical operations	7.	Develop/Execute ladder logic program for logical operations such as AND, OR, NOT, NAND, NOR, X-OR, X-NOR gate along with truth table	CO2
<i>LSO 2.4</i> Program Latch and Unlatch circuit in a PLC for motor operation	8.	Program the given PLC to start run and stop the given motor using latch circuit	CO2
<i>LSO 2.5</i> Create delay in operation using on delay, off delay and retentive timer function in a given PLC.	9.	Test the functionality of on delay, off delay and retentive timer for its correct operation in a given PLC.	CO2
<i>LSO 2.6</i> Count the number of objects/events using Up counter, Down counter and UP/Down counter in a PLC	10.	Test the functionality of Up, Down and Up-down counter for its correct operation in a given PLC.	CO2
<i>LSO 2.7</i> Program PLC using ladder logic to control a LED/Lamp	11.	Develop/Execute a ladder logic program to put LED/lamp in the blinking mode	CO2
<i>LSO 2.8</i> Program PLC using ladder logic to control a simple traffic light system	12.	Develop/Execute a ladder logic program to control a simple traffic light control system using PLC	CO2
<i>LSO 3.1</i> Use hygrometer to measure the humidity inside the panel <i>LSO 3.2</i> Use thermometer to measure ambient temperature inside the panel <i>LSO 3.3</i> Use tester to determine the voltage fluctuation at the power supply terminals is within specifications <i>LSO 3.4</i> Test the ground connections of the given PLC. <i>LSO 3.5</i> A given PLC is not working as per the logic instructions investigate the PLC to identify the cause of failure to show the desired output <i>LSO 3.6</i> Investigate the cause of Noise in the given PLC <i>LSO 3.7</i> PLC goes on blackout out by losing its operating power. Troubleshoot the cause of failure. <i>LSO 3.8</i> Troubleshoot the corrupted PLC memory.	13.	Troubleshooting of PLC system	CO3

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<i>LSO 3.9</i> Replace CPU and power supply fuses in a given PLC system.			
<p><i>LSO 4.1</i> Download any open source SCADA software and install the same.</p> <p><i>LSO 4.2</i> Interpret the available components in symbol factory of SCADA software</p> <p><i>LSO 4.3</i> Create simple SCADA HMI applications and apply dynamic properties. (Select any Three from the given list)</p> <ol style="list-style-type: none"> Turn on and off a tube light using a Switch Apply filling and object size properties to a rectangle, square and round object Move the object, fill the object using slider and meter reading. Apply orientation property to a fan and control its direction using a slider. Move a square object horizontally first, then vertically and again horizontally by applying visibility property. <p><i>LSO 4.4</i> Create historical and real time trends for the given automation</p>	14.	Develop simple SCADA HMI applications using any one open source SCADA software and apply dynamic properties	CO4
<p><i>LSO 5.1</i> Develop a smart irrigation device to detect the change in moisture level in the soil and controls the flow of water accordingly with a DC pump.</p> <p><i>LSO 5.2</i> Build an electronic device that can remotely control home appliances with your Bluetooth-enabled smartphone and a special Android application</p> <p><i>LSO 5.3</i> Develop a PLC program to control the robot in such a way that the robot can automatically pick and place components and works in sync with the conveyor belt system.</p> <p><i>LSO 5.4</i> Develop a Automation system to Open and close the door in the shop</p> <p><i>LSO 5.5</i> Develop a line following robot with RFID sensor for supplying materials and automating workflow.</p> <p><i>LSO 5.6</i> Develop smart street light controlling mechanism which will Switch on/off the lights automatically depending on the intensity of the sunlight at that particular time of the day.</p> <p><i>LSO 5.7</i> Develop smart automated railway crossing system to detect train arrival and departure and send appropriate signals to the microcontroller.</p>	15.	Develop simple automation systems for the given requirement (Select any Three from the given list)	CO5

J) Theory Session Outcomes (TSOs) and Units:T2400604G

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p>TSO 1a. Explain the vehicle movement process</p> <p>TSO 1b. Derive various equations for the movement of Vehicles</p> <p>TSO 1c. Compute different resistances affecting Vehicle movement.</p> <p>TSO 1d. Explain the dynamics of the given type of EV system.</p>	<p>Unit-1.0 Vehicle Dynamics</p> <p>1.1 Vehicle Movement</p> <p>1.2 Rolling Resistance: Equation, Coefficient, factor affecting rolling resistance, typical values of rolling resistance</p> <p>1.3 Grading resistance</p> <p>1.4 Road resistance</p> <p>1.5 Acceleration resistance</p> <p>1.6 Total driving resistance</p> <p>1.7 Aerodynamic drag: Equation, typical values of the drag coefficient.</p> <p>1.8 Vehicle dynamics</p> <ul style="list-style-type: none"> • Hybrid and Electric Vehicles • DC Motor Dynamics and Control • AC Motor Dynamics and Control 	CO1
<p>TSO 2 a. Identify the given elements of Automobile Systems.</p> <p>TSO 2 b. Describe the functions of the given elements of Automobile Systems.</p> <p>TSO 2 c. Explain the dynamic characteristics of the Disc Braking System for the given braking steps.</p> <p>TSO 2 d. Describe the Procedure for testing the given AC/DC motors.</p> <p>TSO 2 e. Describe the Procedure of Installation and Testing of the given EV Charging Stations.</p> <p>TSO 2 f. Describe the Procedure for Commissioning EV Charging Stations.</p> <p>TSO 2 g. Explain the functions of the EV Control Unit.</p>	<p>Unit-2.0 Elements of Automobile</p> <p>2.1 Suspension and Damping systems</p> <p>2.2 Brake system: Half-step braking, Full step Braking</p> <p>2.3 Transaxle</p> <p>2.4 Elements of Noise Vibration and Harshness Control</p> <p>2.5 Body balancing</p> <p>2.6 Tyre Technology</p> <p>2.7 AC/DC motor</p> <p>2.8 Air-conditioning and Heating System</p> <p>2.9 Lighting System</p> <p>2.10 Automotive wiring system</p> <p>2.11 Earthing and Insulation</p> <p>2.12 Charging stations – Installation and Commissioning</p> <p>2.13 Vehicle control unit</p>	CO2
<p>TSO 3a. Compare different power transmission systems in EVs.</p> <p>TSO 3b. List the main Components of the EV Power Train.</p> <p>TSO 3c. Explain the functions of the given EV Power Train component.</p> <p>TSO 3d. Describe the testing procedure of the given EV Power Train component.</p> <p>TSO 3e. Explain the regenerative braking operation in the given EV motor.</p> <p>TSO 3f. Describe the speed control mechanism of the given motor.</p> <p>TSO 3g. Explain various parameters of the given battery.</p> <p>TSO 3h. Select the suitable battery for the given EV application.</p> <p>TSO 3i. Describe the assembling and dismantling procedure of the given battery.</p>	<p>Unit-3.0 EV Power Transmission System</p> <p>3.1 Transmission System: Single and Multi-transmission system</p> <p>3.2 EV Power Train</p> <p>3.3 EV Power Train Components: Battery Pack, DC-AC Converter, Electric Motor, On-Board Charger.</p> <p>3.4 Battery Parameters: Voltage, Current, Charging rate, efficiency, energy density, power density, State of Charge (SoC), Depth of Discharge (DoD), State of Health (SoH), Operating Temperature, specific energy, specific power, life cycle and cost.</p> <p>3.5 Battery Assembly and Dismantling.</p> <p>3.6 Gear and Differential Assembly</p> <p>3.7 Safe disposal of used battery</p>	CO3

Major Theory Session Outcomes (TSOs)		Units	Relevant COs Number(s)
TSO 3j.	Describe the Mechanism of Gear and Differential Assembly.		
TSO 4a. TSO 4b. TSO 4c. TSO 4d. TSO 4e.	Describe the Vehicle Control Unit (VCU). Describe the functions of the given component of the Electronic Control Unit. Describe the connections of the given control unit with the EV sub-system. Explain the Interaction of Controller Area Network Communication with VCU. Describe the Troubleshooting and Assessment procedure of VCU.	Unit- 4.0 Vehicle Control Unit (VCU) 4.1 Electronic Control Unit: Battery Management System, DC-DC Converter, Thermal Management System and Body Control Module. 4.2 Predefined functions 4.3 Connections with EV subsystem 4.4 Controller Area Network (CAN) communication 4.5 Interaction of CAN Communication with VCU. 4.6 Troubleshooting and Assessment 4.7 Dynamometers: Introduction 4.8 Environmental Chambers	CO4
TSO 5a. TSO 5b. TSO 5c. TSO 5d. TSO 5e.	Explain the Classification of Charging Technologies. Explain the impact of the Grid on Vehicle Charging and Vehicle Charging on the Grid. Describe the testing procedure of the given Bi-directional charging systems. Explain the Energy Management Strategies in the EV. Explain the Wireless Power Transfer (WPT) technique for EV Charging.	Unit- 5.0 EV Charging Technologies 5.1 Charging Technology: Classification 5.2 Grid-to-Vehicle (G2V) 5.3 Vehicle to Grid (V2G) or Vehicle to Buildings (V2B) or Vehicle to Home(V2H). 5.4 Bi-directional EV Charging Systems. 5.5 Energy Management Strategies. 5.6 Wireless Power Transfer (WPT) technique for EV Charging.	CO5

Note: One major TSO may require more than one theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical:P2400604G

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 2.1 Test the operation of the Control Disc Braking system and control the regenerative braking system using a test rig. LSO 2.2 Test the performance (Speed v/s Braking Torque) of the Disc Braking System in Half step and Full step braking modes.	1.	<ul style="list-style-type: none"> Testing of Control Disc Braking system and Control Regenerative Braking system. 	CO2
LSO 2.3 Test the performance of different types of propulsion motors.	2.	<ul style="list-style-type: none"> Testing of Motors 	
LSO 2.4 Test the continuity of the automotive wiring system in the EV	3.	<ul style="list-style-type: none"> Testing of the automotive wiring system. 	
LSO 3.1 Test the performance of a new set of batteries and aged batteries. LSO 3.2 Compare the performance of the battery and find the Fuel Gauge after discharging the battery. a. 0% - 100% b. 30% - 100% c. 50% - 100% LSO 3.3 Evaluate the following parameters of the given EV battery.	4.	<ul style="list-style-type: none"> Testing of Batteries used in EVs 	CO2, CO3

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
a. Specific power b. Specific energy c. Life span and d. Cost parameters LSO 3.4 Evaluate the State of Health (SoH) of the given EV Battery after several charge/discharge cycles.			
LSO 3.5 Test the dynamic performance of the given motor; a) Speed and torque spectrum. b) Speed and torque oscillation c) Friction torque friction spectrum. LSO 3.6 Test the following speed-controlled performance characteristics of the given motor; a. Motor voltage over time b. Motor current over time. c. Speed and torque over time. d. Torque over speed. e. Current over speed. f. Electrical input power and the mechanical input power over speed	5.	<ul style="list-style-type: none"> Speed control of Electrical Motors 	
LSO 4.1 Connect the components of the EC Units with EV subsystems. LSO 4.2 Troubleshoot basic faults in the electronic control unit of EV.	6.	<ul style="list-style-type: none"> Connection of Electronic Control Unit components Troubleshooting of electronic control unit 	CO4
LSO 5.1 Evaluate the impact of the Grid on Vehicle Charging and Vehicle Charging on the Grid.	7.	<ul style="list-style-type: none"> Impacts of G2V and V2G 	CO 5
LSO 5.2 Prepare a layout of a charging station	8.	<ul style="list-style-type: none"> Demonstration of Charging stations 	

L) **Suggested Term Work and Self-Learning: S2400604G** Some sample suggested assignments, micro projects and other activities are mentioned here for reference.

a. **Assignments:** Questions/ Problems/ Numerical/ Exercises to be provided by the course teacher in line with the targeted COs.

b. **Micro Projects:**

- Design and build a physical model of an EV motor and powertrain components from scratch.
- Build and simulate communication systems of EVs using some software tools.
- Prepare a report on “the way carbon credit works and companies utilize it to reduce their emission values”.
- Develop an EV prototype power train using locally procured hardware components.

c. **Other Activities:**

1. **Seminar Topics:**

- Safe disposal process of Used Batteries.
- Charging Technologies used for charging the EV.
- EV power transmission systems.

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances/ problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400604H	Robotics (Advanced)	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done internally (40%) as well as externally (60%). Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2400604H

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Define the need and scope of industrial robots. TSO 1b. Describe the concept of robot dynamics with regards to methods for orientation and location of objects. TSO 1c. Analyse robot direct kinematics for the given 2 DOF planar manipulator. TSO 1d. List types of robots TSO 1e. List safety steps while handling the given robot.	Unit-1.0 Robot Kinematics, Dynamics and Industrial Applications 1.1 Definition need and scope of Industrial robots 1.2 Robot dynamics – Methods for orientation and location of objects 1.3 Planar Robot Kinematics – Direct and inverse kinematics for 2 Degrees of Freedom.	CO2, CO3

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1f. Interface robots with the given welding machine.	1.4 Safety while operating and handling robot	
TSO 1g. Interface robots with the given painting machine. TSO 1h. Interface robots with the given assembly machine.	1.5 Robot Industrial applications: <ul style="list-style-type: none"> Welding Robots-Welding Guns, Welding Electrodes, Welding Power Sources, shielding gases, Robot interfacing Spray painting Robots, assembly operation, cleaning. 	
TSO 2a. Explain the techniques to control robot motion. TSO 2b. Describe the given robot drive system. TSO 2c. Describe the types of grippers. TSO 2d. Design grippers for specific application. TSO 2e. Test the designed gripper for the application. TSO 2f. Use Bar code technology for robotic applications. TSO 2g. Integrate radio frequency identification technology in robotic applications. TSO 2h. Assemble an automated guided vehicle for the given situation using standard components. TSO 2i. Assemble a simple automated storage and retrieval systems (ASRS) for the given situation using standard components.	Unit– 2.0 Robot Drives, Control and Material Handling 2.1 Controlling the Robot motion. 2.2 Position and velocity sensing devices. 2.3 Drive systems – Hydraulic and Pneumatic drives 2.4 Linear and rotary actuators and control valves 2.5 Electro hydraulic servo valves, electric drives, motors 2.6 End effectors – Vacuum, magnetic and air operated grippers 2.7 Material Handling; automated guided vehicle systems, automated storage and retrieval systems (ASRS) 2.8 Bar code technology 2.9 Radio frequency identification technology.	CO2, CO3
TSO 3a. Differentiate between various work cell layouts. TSO 3b. Select work cell for specific robot with justification. TSO 3c. Analyse robot cycle time. TSO 3d. Explain industrial applications of robotic cell. TSO 3e. Follow safety procedures in robotic cell.	Unit– 3.0 Robot Cell Design and Application 3.1 Robot work cell design, control and safety 3.2 Robot cell layouts 3.3 Multiple Robots and machine interference 3.4 Robot cycle time analysis 3.5 Industrial application of robotic cells	CO3
TSO 4a. List different programming languages for the robots TSO 4b. Describe artificial intelligence TSO 4c. Write a programme in the required language to operate a robot for the given task. TSO 4d. Optimise robot programming parameters. TSO 4e. Select a robot on the basis of cycle time analysis. TSO 4f. Conduct an economic analysis for use of robots. TSO 4g. Follow testing methods and acceptance rules for industrial robots.	Unit– 4.0 Robot Programming and Economics of Robotization 4.1 Characteristics of task level languages through programming methods 4.2 Motion interpolation 4.3 Artificial intelligence: Goals of artificial intelligence, AI techniques, problem representation in AI 4.4 Problem reduction and solution techniques. 4.5 Application of AI and KBES in Robots 4.6 Selection of Robots; Factors influencing the choice of a robot, selection of robot components, robot performance testing, work cycle time analysis 4.7 Economics analysis for robotics, cost data required for the analysis 4.8 Methods of economic analysis; Pay back method, equivalent uniform annual cost method, return on investment method. 4.9 Testing methods and acceptance rules for industrial robots	CO1, CO4, CO5

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 5a. Describe applications of robots in healthcare and medicine. TSO 5b. Describe applications of robots in Construction industry. TSO 5c. Describe applications of robots in Underground coal mining. TSO 5d. Describe applications of robots in utilities, military & firefighting operations. TSO 5e. Describe applications of robots in undersea and space TSO 5f. Describe applications of robots in brief in logistics, retail and hospitality, and smart cities. TSO 5g. Describe applications of robots in farming and agriculture in brief explain in brief the use of microrobots, nano robots, soft robots, humanoid robots	Unit-5.0 Applications in Non-manufacturing Environments 5.1 Applications of Robots in <ul style="list-style-type: none"> ● Healthcare and medicine ● Construction industry ● Underground coal mines ● Utilities, military & firefighting operations ● Undersea ● Space ● Logistics, ● Retail and Hospitality ● Smart Cities ● Farming and Agriculture 5.2 Overview of Microrobots, nano robots, soft robots, humanoid robots	CO5

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400604H

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1 Identify Wireless Sensor Network. LSO 1.2 Use wireless sensor Network for different robotic applications	1.	Identify different wireless sensor network in robotics viz. ZigBee, LoRa.	CO1, CO3
LSO 2.1 Identify different Radio Frequency (RF) Controlled Wireless LSO 2.2 Use Radio Frequency (RF) Controlled Wireless for different robotic applications.	2.	Use different Radio Frequency (RF) Controlled Wireless Robots.	CO1, CO2
LSO 3.1 Identify the different Voice operated robot with speaker identification technology LSO 3.2 Use different Voice operated robot with speaker identification technology for different robotic applications.	3.	Examine different voice operated robot with speaker identification technology.	CO1, CO3
LSO 4.1 Identify the components required for a computer-controlled pick and place robot (wireless). LSO 4.2 Integrate the components for the required application.	4.	Design a computer-controlled pick and place robot (wireless)	CO1
LSO 5.1 Identify the components required for a Zigbee controlled Boat with wireless video and voice transmission. LSO 5.2 Integrate the components for the required application.	5.	Design a Zigbee controlled Boat with wireless video and voice transmission.	CO2, CO3
LSO 6.1 Identify the components required for a PC controlled wireless Multipurpose robot for engineering applications. LSO 6.2 Integrate the components for the required application.	6.	Design a PC controlled wireless Multipurpose robot for simple engineering applications.	CO2, CO4, CO5
LSO 7.1 Identify the components required for an unmanned arial photography	7.	Design an unmanned arial photography system.	CO3, CO5

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 7.2 Integrate the components for the required application.			
LSO 8.1 Develop a program LSO 8.2 Simulate palletizing and depalletizing operations through robots.	8.	Develop program for real time (online TPP) Palletizing and Depalletizing operations through robots.	CO5
LSO 9.1 Develop a program LSO 9.2 Simulate direction control and step control logic for robotization	9.	Develop TPP / Offline program for vision-based inspection for robots.	CO4, CO5
LSO 10.1 Develop a program LSO 10.2 Simulate robotising an inspection and part assembly.	10.	Program and simulate coordinated identification, inspection and part assembly for robots.	CO1, CO5
LSO 11.1 Develop a program. LSO 11.2 Simulate obstacle avoidance of robots.	11.	Develop obstacle avoidance robot Programming	CO1, CO5
LSO 12.1 PLC programming. LSO 12.2 Simulate robotising of welding operation.	12.	Program and simulate welding operation using robot simulation software.	CO1, CO5
LSO 13.1 Simulate robotising of drilling operation.	13.	TPP / Offline program for drilling operation.	CO1, CO5
LSO 14.1 Develop a program for an industrial application. LSO 14.2 Execute the robot programme.	14.	Program to execute an industrial robot application using a given configuration.	CO1, CO5
LSO 15.1 Use robot simulation software for Direct Kinematic analysis upto 4-axis robots LSO 15.2 Correlate the simulated results with respective mathematical calculations.	15.	Analyse Direct Kinematics of 4-axis robot using available software.	CO2

L) **Suggested Term Work and Self Learning: S2400604H** Some sample suggested assignments, micro project and other activities are mentioned here for reference.

- a. **Assignments:** Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.
- b. **Micro Projects:** A suggestive list of micro-projects is given here. Similar micro-projects that match the COs could be added by the concerned course teacher. The student should strive to identify eco-friendly or recycled material prior to selection for robotic applications.
 1. Develop coin separating robot.
 2. Develop robot using radio frequency sensors for material handling.
 3. Develop robot for land mine detection.
 4. Develop a robot for car washing.
- c. **Other Activities:**
 1. Seminar Topics: Recent developments in the industrial applications of robotics
 2. Visits: Visit a robotic exhibition.
 3. Case Study: Identify a robotic application in automobiles and present a case study
 4. Download videos related to simple robotic applications in domestic and industrial purposes.
 5. Self-Learning Topics:
 - Robotic component manufacturers

J) Theory Session Outcomes (TSOs) and Units: T2400604I

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1a.</i> Explain the use of different materials in transformers.</p> <p><i>TSO 1b.</i> List the various types of materials used in transformers.</p> <p><i>TSO 1c.</i> Explain the insulating materials.</p> <p><i>TSO 1d.</i> Explain the winding material.</p> <p><i>TSO 1e.</i> Explain the magnetic materials.</p>	<p>Unit-1.0 Transformer Materials</p> <p>1.1 Review of basic materials and their processing</p> <p>1.2 Insulating oil, insulating paper, pressboard, wood</p> <p>1.3 Insulated copper conductor for windings, crepe paper, sealing materials</p> <p>1.4 cold-rolled grain oriented electrical steel sheet, structural steel, future trends</p> <p>1.5 Magnetic Circuit Materials</p>	CO1
<p><i>TSO 2a.</i> Explain the basic concept of transformer design.</p> <p><i>TSO 2b.</i> List the various parameters to be considered during design.</p> <p><i>TSO 2c.</i> Choose the number of turns, the core diameter.</p> <p><i>TSO 2d.</i> Select the winding wires and strips.</p> <p><i>TSO 2e.</i> Choose the size of HV and LV conductors.</p>	<p>Unit-2.0 Transformer Design</p> <p>2.1 Basic Concept of Design.</p> <p>2.2 Selection of number of turns.</p> <p>2.3 Selection of core diameter.</p> <p>2.4 Selection of winding wires and strips.</p> <p>2.5 Size HV and LV conductors.</p> <p>2.6 Transposition</p>	CO1, CO2
<p><i>TSO 3a.</i> Explain the concept of computer aided design.</p> <p><i>TSO 3b.</i> Learn the programming skills,</p> <p><i>TSO 3c.</i> Modify the programming considering other aspects.</p> <p><i>TSO 3d.</i> Validate and print the design.</p> <p><i>TSO 3e.</i> Use software to design.</p>	<p>Unit-3.0 Transformer Design – Using CAD</p> <p>3.1 Computer aided design: Basic concept, specification needs.</p> <p>3.2 Computer programming, variable inputs, program convergence.</p> <p>3.3 Design output, design modification, other aspects of design.</p> <p>3.4 Design validation, design package, computer design printout.</p> <p>3.5 Software application for design.</p>	CO3, CO4
<p><i>TSO 4a.</i> Explain the testing of Transformer oil.</p> <p><i>TSO 4b.</i> Use of Transformer oil.</p> <p><i>TSO 4c.</i> List the causes of oil ageing.</p> <p><i>TSO 4d.</i> List the various tests to monitor the working conditions of a transformer.</p>	<p>Unit-4.0 Transformer Condition Monitoring</p> <p>4.1 Transformer oil testing and Interpretation</p> <p>4.2 Introduction, mineral insulating oil.</p> <p>4.3 Four functions of transformer oil.</p> <p>4.4 Causes of oil ageing.</p> <p>4.5 Various tests on transformer oil such as power factor, moisture, neutralization number, interfacial tension, relative density, color, visual examination, breakdown voltage, dissolved gas analysis.</p>	CO3, CO4
<p><i>TSO 5a.</i> Apply the concepts for practical use.</p> <p><i>TSO 5b.</i> Design a practical power transformer.</p>	<p>Unit-5.0 Transformer Design - Practical Applications</p> <p>5.1 Design of a 100 KVA transformer.</p> <p>5.2 Design of 630 KVA transformer.</p> <p>5.3 Design of 5 MVA, 33/11 KV transformer</p>	CO4, CO5

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400604I

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<i>LSO 1.1.</i> Knowledge of knowing the various components of a power transformer. <i>LSO 1.2.</i> Explain the use of those components in the power transformer.	1.	Dismantling a power transformer and understanding various components.	CO1
<i>LSO 2.1.</i> Design a transformer using computer programming considering various aspects.	2.	Designing a transformer using computer programming.	CO1
<i>LSO 3.1.</i> Use of a commercial software to design a transformer.	3.	Application of software for transformer design.	CO1
<i>LSO 4.1.</i> Understand the breakdown voltage (BDV) of transformer oil.	4.	Breakdown voltage test of transformer oil.	CO2
<i>LSO 5.1.</i> Explain the practical applications of power transformers. <i>LSO 5.2.</i> Knowledge of various transformers used in substations.	5.	Substation visit to see the application of power transformers.	CO3, CO4, CO5

L) Suggested Term Work and Self Learning: S2400604I Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

- Explore recent advancements in core material technology.
- Discuss the lifecycle, recycling, and disposal of transformer materials and their environmental footprint.
- Discuss the key parameters and design equations used in transformer design.
- Explore the steps involved in modeling the transformer core using CAD software.
- Use CAD software to simulate different winding configurations and their impact on performance.
- Discuss the advantages of real-time data collection and analysis for proactive maintenance.
- Investigate the different requirements for distribution transformers in urban versus rural settings.

b. Micro Projects:

- Compare the performance of different insulating materials used in transformers (e.g., paper, pressboard, Nomex).
- Study the magnetic properties of different core materials (e.g., silicon steel, amorphous steel).
- Evaluate the environmental impact of transformer materials and their disposal methods.
- Build a small-scale transformer to understand the basics of transformer construction and operation.
- Investigate the impact of different winding techniques on transformer efficiency and performance.
- Compare different core materials to determine their effect on transformer performance.
- Design various core shapes (e.g., E-core, toroidal, C-core) using CAD and analyze their magnetic properties.
- Design and optimize different winding layouts to improve efficiency and reduce losses.
- Design a system to monitor and log the temperature of transformer components.
- Monitor transformer vibrations to detect mechanical issues.
- Design a system to monitor the quality of transformer oil.
- Develop a lightweight, portable transformer for powering equipment at outdoor events.

Legend:

- CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)
- LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)
- Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.
- TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)
- SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.
- C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)
- Note:** TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400604J	Optical Fiber and 5G Communication (Advance)	30	70	20	30	20	30	200

Legend:

- PTA: Progressive Theory Assessment in classroom (includes class test, mid-term test and quiz using online/offline modes)
- PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)
- TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.)

Note:

- Separate passing is must for progressive and end semester assessment for both theory and practical.
- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

- II) Course Curriculum Detailing:** This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2400604J

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1f.</i> Highlight the need for 5G communication system.</p> <p><i>TSO 1g.</i> Describe the radio spectrum and channel model with the help of suitable sketch and tables.</p> <p><i>TSO 1h.</i> Describe the working of the 5G physical layer with the help of a suitable sketch.</p> <p><i>TSO 1i.</i> Describe 5G network slicing with an example.</p> <p><i>TSO 1j.</i> Explain the mobility and hand-off management in 5G environment.</p>	<p>Unit-1.0 5G Radio Access Technology</p> <p>1.6 5G Radio Spectrum</p> <p>1.7 5G Channel Model</p> <p>1.8 Radio Interface Architecture</p> <p>1.9 5G Physical Layer</p> <p>1.10 5G Radio-Access Technologies</p> <p>1.11 Introduction To 5G Network Slicing</p> <p>1.12 Mobility and Handoff Management In 5G</p>	CO1
<p><i>TSO 2f.</i> Describe the architecture and key components of basic GSM (Global System for Mobile Communications) networks.</p> <p><i>TSO 2g.</i> List the components of the GSM(LTE) system.</p> <p><i>TSO 2h.</i> Describe the working of the various components and their functions of the given type of wireless communication network</p> <p><i>TSO 2i.</i> Analyze the functions of base station subsystems (BS)</p>	<p>Unit-2.0 Study of GSM Architecture</p> <p>2.7 GSM System Architecture (LTE)</p> <p>2.8 Explain the different components of Wireless Communication Network</p> <p>2.9 Operation of base station (BS) subsystems</p>	CO2
<p><i>TSO 3f.</i> Explain different principles and various factors affecting radio wave propagation in different environments.</p> <p><i>TSO 3g.</i> Apply the free space propagation model to estimate signal strength and coverage.</p> <p><i>TSO 3h.</i> Explain how reflection, scattering, and diffraction impact radio wave behaviour and signal quality.</p> <p><i>TSO 3i.</i> Use the given type of path loss models to predict signal degradation over distance.</p> <p><i>TSO 3j.</i> Differentiate between large-scale and small-scale fading and their effects on wireless communication.</p> <p><i>TSO 3k.</i> Analyze the characteristics and behaviour of wireless channels, including their impact on signal transmission.</p> <p><i>TSO 3l.</i> List the noise sources present in the wireless channel.</p> <p><i>TSO 3m.</i> Describe the effects of noise on signal propagation through wireless channels and its impact on signal quality.</p> <p><i>TSO 3n.</i> Calculate the capacity of channels with Additive White Gaussian Noise (AWGN).</p>	<p>Unit-3.0 Channel and channel behavior</p> <p>3.6 Analysis of radio wave propagation</p> <p>3.7 Free Space Propagation Model</p> <p>3.8 Reflection, Scattering, Diffraction of Radio Waves</p> <p>3.9 Path Loss Models</p> <p>3.10 Study of Fading (Large, small-scale fading)</p> <p>3.11 Analysis of Wireless Channel</p> <p>3.12 Analysis of Noise, types of noise</p> <p>3.13 Capacity of AWGN and Fading Channel (only formula and its variable parameters)</p>	CO3
<p><i>TSO 4e.</i> Describe various diversity techniques to improve signal reliability and performance in wireless communication.</p> <p><i>TSO 4f.</i> Describe receiver diversity methods and their impact on enhancing signal quality and reducing errors.</p> <p><i>TSO 4g.</i> Describe transmitter diversity techniques and their role in mitigating fading and improving communication robustness.</p> <p><i>TSO 4h.</i> Describe the principles and applications of Multiple Input Multiple Output (MIMO) technology.</p> <p><i>TSO 4i.</i> Suggest the techniques to correct distortions and mitigate inter-symbol interference in wireless communication systems.</p>	<p>Unit-4.0 Mitigation Techniques</p> <p>4.6 Diversity techniques</p> <p>4.7 Analysis of various receiver diversity techniques</p> <p>4.8 Analysis of various transmitter diversity techniques</p> <p>4.9 MIMO technology advantages in communication systems</p> <p>4.10 Equalization techniques and their importance in communication systems</p>	CO4
<p><i>TSO 5c.</i> Discuss the various types of dispersion in optical fibre design</p> <p><i>TSO 5d.</i> Explain the optimization technique of single mode fibre.</p> <p><i>TSO 5e.</i> Describe the working and characteristics of different optical networks.</p> <p><i>TSO 5f.</i> Explain the nonlinear effect on network performance of</p>	<p>Unit-5.0 Advanced Optical Fiber Communication and Emerging Technologies</p> <p>5.4 Advanced Optical Fiber: Dispersion issues, Dispersion shifted, Dispersion flattened, Dispersion Compensating fibre</p> <p>5.5 Design and optimization of single-mode fibers</p> <p>5.6 Optical Networks- Basic Networks SONET, SDH-</p>	CO5

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p>optical fibre systems.</p> <p><i>TSO 5g.</i> Explain multicarrier modulation techniques to enhance data transmission and system performance.</p> <p><i>TSO 5h.</i> Describe the principles and advantages of Orthogonal Frequency Division Multiplexing (OFDM) in improving bandwidth efficiency and reducing interference.</p> <p><i>TSO 5i.</i> Analyze given emerging technologies.</p>	<p>wavelength-routed networks</p> <p>5.7 Nonlinear effect on Network Performance, performance of various systems (WDM, DWDM + SOA)</p> <p>5.8 Multicarrier Modulation Technique</p> <p>5.9 Orthogonal Frequency Division Multiplexing (OFDM)</p> <p>5.10 Emerging Technology: Green Communication network, Vehicle 2 everything (V2X), Aerial Communication, Satellite Communication (LEO), Tactile Internet (TI), Free Space Optics (FSO), Near Field Communication, Quantum Communication, Molecular Communication</p>	

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400604J

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<i>LSO 1.3.</i> Noise Modelling and its effect on Wireless Data Transmission	1.	Characterization and Impact of Noise on Wireless Data Transmission: A Comprehensive	CO1
<i>LSO 2.2.</i> Effect of fading on wireless data transmission in terms of outage probability	2.	Evaluating Fading Effects on Wireless Data Transmission: Outage Probability Analysis	CO2
<i>LSO 3.2.</i> Capacity of Wireless Channel (AWGN v/s Fading)	3.	Comparative Study of Channel Capacity: AWGN versus Fading Channels	CO3
<i>LSO 4.2.</i> Implementation of receiver diversity technique.	4.	Practical Implementation and Evaluation of Receiver Diversity Techniques in Wireless Communication	CO4
<i>LSO 5.3.</i> Implementation of transmitter diversity technique.	5.	Practical Implementation and Performance Analysis of Transmitter Diversity Techniques	CO4
<i>LSO 6.1</i> Implement the (2X2) of MIMO system.	6.	Design and Implementation of MIMO Technology	CO4
<i>LSO 7.1</i> Implement of OFDM system and test the performance.	7.	Performance Evaluation of Orthogonal Frequency Division Multiplexing (OFDM) in Wireless Systems	CO5

L) **Suggested Term Work and Self Learning: S2400604J** Some sample suggested assignments, micro project and other activities are mentioned here for reference.

d. **Assignments:** Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

e. **Micro Projects:**

Here are five micro projects that can be included in an optical fiber and 5G communication course to give students hands-on experience with practical applications of the concepts learned:

1. Design of solar cell enabled Base Station for Green Communication Network

Task: Conduct a feasibility study on integrating solar cells with base stations, design a prototype solar-powered base station, simulate its energy efficiency and environmental impact, evaluate its carbon footprint reduction, and document the design and performance outcomes.

2. Path loss models for Aerial Communication Network

Task: Research and adapt existing path loss models for aerial networks, develop tailored models for scenarios like drones, validate with field or simulation data, compare model performance, and document findings with recommendations for network design.

3. Resource allocation for 5G communication Network

Task: Identify challenges in 5G resource allocation, develop an optimization strategy, simulate the strategy's effectiveness, implement it in a test environment, and analyze results to enhance resource allocation and network performance.