

**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 – V

### Teaching & Learning Scheme

Course Codes	Category of course	CourseTitles	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				
2418501	PCC	Data Communication and Computer Network	03	-	04	02	09	06
2418502	PCC	Software Engineering	02	01	-	02	05	04
2418503	PEC	Programme Electives* - Any One	03	-	04	02	09	06
2400504	OEC	Open Electives**/ COE (Basic - Any One)	03	-	04	02	09	06
2400505	NRC	Entrepreneurship Development & Start-ups (Common for All Programmes)	-	-	04	02	06	03
2418506	PSI	Summer Internship- II (After 4 <sup>th</sup> Sem) / Industrial Training (Common for all programmes)	-	-	02	04	06	03
2418507	PSI	Minor Project (Common for all programmes)	-	-	02	02	04	02
<b>Total</b>			<b>11</b>	<b>1</b>	<b>20</b>	<b>16</b>	<b>48</b>	<b>30</b>

**Note: Prefix will be added to course code if applicable (T for Theory Paper, 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)

\*: Data Science: Data Warehousing and Data Mining / Advanced JAVA Programming

\*: 3D Printing & Design/ Art. Intelligence (AI)/ Drone Technology / Electric Vehicle / Ind. Automation / Robotics/ IOT/Transformer Manufacturing & 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 - V 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)	
2418501	PCC	Data Communication and Computer Network	30	70	20	30	20	30	200
2418502	PCC	Software Engineering	30	70	20	30	-	-	150
2418503	PEC	Programme Electives* - Any One	30	70	20	30	20	30	200
2400504	OEC	Open Electives**/ COE (Basic - Any One)	30	70	20	30	20	30	200
2400505	NRC	Entrepreneurship Development & Start-ups (Common for All Programmes)	-	-	20	30	20	30	100
2418506	PSI	Summer Internship- II (After 4 <sup>th</sup> Sem) / Industrial Training (Common for all programmes)	-	-	20	30	20	30	100
2418507	PSI	Minor Project (Common for all programmes)	-	-	10	15	10	15	50
<b>Total</b>			<b>120</b>	<b>280</b>	<b>130</b>	<b>195</b>	<b>110</b>	<b>165</b>	<b>1000</b>

**Note: Prefix will be added to course code if applicable (T for Theory Paper, 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.
- \*: Data Science: Data Warehousing and Data Mining / Advanced JAVA Programming
- 3D Printing & Design/ Art. Intelligence (AI)/ Drone Technology / Electric Vehicle / Ind. Automation / Robotics/ IOT/Transformer Manufacturing & 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 (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: T2418501**

Major Theory Session Outcomes (TSOs)	Units	Relevant Cos Number(s)
<p><i>TSO 1a.</i> Explain the process of data communication and its components.</p> <p><i>TSO 1b.</i> Explain the following terms in data communication:-</p> <p><i>TSO 1c.</i> Bandwidth, data transmission rate and baud rate.</p> <p><i>TSO 1d.</i> Differentiate between various models of communication and their applications.</p> <p><i>TSO 1e.</i> Differentiate between analog and digital signal transmission and the conversion processes between them.</p> <p><i>TSO 1f.</i> Select relevant type of transmission media depending on requirements.</p> <p><i>TSO 1g.</i> Classify the given networks into LAN and WAN</p> <p><i>TSO 1h.</i> List the different guided Transmission Media and Unguided Transmission Media</p> <p><i>TSO 1i.</i> Identify various Multiplexing and Switching techniques used in digital communication</p>	<p><b>Unit-1.0 Data Communications and Transmission Media</b></p> <p>1.1 Process of data communication and its components: Transmitter, Receiver, Medium, Message, Protocol.</p> <p>1.2 Protocol, Standard, Standard organization. Bandwidth, Data Transmission Rate, Baud Rate and Bits per second</p> <p>1.3 Models of Communication (Simplex, Half Duplex, full Duplex)</p> <p>1.4 Analog Signal and Digital Signal Transmission: Analog to Digital, Digital to Analog Conversion</p> <p>1.5 Fundamentals of Computer Network: Definition and Need of Computer Network, Application, Network Benefits.</p> <p>1.6 Classification of Network LAN and WAN</p> <p>1.7 Network Architecture: Peer to peer, Client Server Network</p> <p>1.8 Communication Media: guided Transmission Media, Twisted-Pair Cable, Coaxial Cable Fiber-optic Cable</p> <p>1.9 Unguided Transmission Media, Radio Waves, Microwaves, Infrared, Satellite</p> <p>1.10 Multiplexing: Frequency-Division Multiplexing, Time-Division Multiplexing.</p>	<p><b>CO-1</b></p>
<p>TSO.2.a Distinguish between error detection and error correction.</p> <p>TSO.2.b Explain the coding techniques for data integrity.</p> <p>TSO.2.c Calculate cyclic codes and checksum for error detection.</p> <p>TSO.2.d Recognize the importance of framing in data transmission.</p> <p>TSO.2.e Explain the techniques for error control in data communication.</p>	<p><b>Unit 2.0 Data Link Layer</b></p> <p>2.1 <b>Introduction:</b> Types of Errors, Redundancy, Detection Versus Correction, Coding</p> <p>2.2 <b>Block coding:</b> Error Detection, Error Correction Hamming Distance, Minimum Hamming Distance</p> <p>2.3 <b>Cyclic codes:</b> Cyclic Redundancy Check, Polynomials, Cyclic Code Analysis, CHECKSUM</p> <p>2.4 <b>Framing:</b> Fixed-Size Framing, Variable-Size Framing</p>	<p><b>CO-2</b></p>

Major Theory Session Outcomes (TSOs)	Units	Relevant Cos Number(s)
<p>TSO.2.f Explain the function of Noisy and Noiseless channel protocols</p> <p>TSO.2.g Explain the function of medium access control protocols.</p> <p>TSO.2.h Explain the function of different channel partitioning protocols.</p> <p>TSO.2.i Describe different types of Ethernets.</p> <p>TSO.2.j Differentiate between various network connecting devices working at different TCP/IP layers.</p>	<p>2.5 <b>Flow and error control:</b> Flow Control, Error Control</p> <p>2.6 <b>Noiseless channels:</b> Simplest Protocol, Stop-and-Wait Protocol</p> <p>2.7 <b>Noisy channels:</b> Stop-and-Wait Automatic Repeat Request, Go-Back-N Automatic Repeat Request, Selective Repeat Automatic Repeat Request, Piggybacking.</p> <p><b>2.8 Point-to-point protocol</b></p> <p>2.9 <b>Random access:</b> ALOHA, Carrier Sense Multiple Access (CSMA), Carrier Sense Multiple Access with Collision Detection (CSMA/CD), Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA)</p> <p>2.10 <b>Channelization:</b> Frequency-Division Multiple Access (FDMA), Time-Division Multiple Access (TDMA), Code-Division Multiple Access (CDMA)</p> <p>2.11 <b>Ethernet:</b> Bridged Ethernet, Switched Ethernet, Fast Ethernet, Gigabit Ethernet</p> <p>2.12 <b>Connecting devices:</b> HUBs, Two-Layer Switches, Routers, Three-Layer Switches, Gateway</p>	
<p>TSO 3a. Write different notations for IPv4 addresses.</p> <p>TSO 3b. Differentiate between classful and classless addressing.</p> <p>TSO 3c. Explain the function of Network Address Translation (NAT).</p> <p>TSO 3d. Explain process of fragmentation in network layer protocols.</p> <p>TSO 3e. Explain the functioning of ARP and RARP protocols.</p> <p>TSO 3f. Explain the mechanism of packet receiving and forwarding in routing process.</p> <p>TSO 3g. Differentiate between unicast and multicast routing protocols.</p>	<p><b>Unit 3.0 Network Layer</b></p> <p>3.1 <b>IPv4 addresses:</b> Address Space, Notations, Classful Addressing, special case IP addresses, subnet, supernet, Classless Addressing, Network Address Translation (NAT), Datagram Fragmentation, Checksum, Options</p> <p>3.2</p> <p>3.3 <b>Introduction to IPv6:</b> Advantages, Tunneling</p> <p>3.4 <b>Address mapping:</b> Logical to Physical Address: ARP, Mapping Physical to Logical Address: RARP.</p> <p>3.5 <b>Router Forwarding table, and Routing:</b> Function of unicast and multicast routing protocols</p>	CO-3
<p>TSO 4a. Explain client/server paradigm in process-to-process delivery.</p> <p>TSO 4b. Explain the concepts of multiplexing and demultiplexing at transport layer.</p> <p>TSO 4c. Differentiate between connectionless and connection-oriented services.</p> <p>TSO 4d. Differentiate between reliable and unreliable communication.</p> <p>TSO 4e. Differentiate the functioning of TCP and UDP protocol.</p>	<p><b>Unit 4.0 Transport Layer</b></p> <p>4.1 <b>Process to Process Delivery:</b> -Client/Server Paradigm, Multiplexing and Demultiplexing, Connectionless Versus Connection-Oriented Service, Reliable Versus Unreliable</p> <p>4.2 User datagram protocol (UDP): -Well-Known Ports for UDP, User Datagram, Checksum, UDP Operation, Use of UDP</p>	CO-4

Major Theory Session Outcomes (TSOs)	Units	Relevant Cos Number(s)
<p><i>TSO 4f.</i> Explain flow control mechanisms in TCP.</p> <p><i>TSO 4g.</i> Differentiate between open-loop and closed-loop congestion control.</p>	<p>4.3 TCP: -TCP Services Features, Segment, A TCP Connection, Flow Control, Error Control</p> <p>4.4 Congestion Control: - Open-Loop Congestion Control, Closed-Loop Congestion Control</p>	
<p><i>TSO 5a.</i> Explain the functioning of DNS protocol.</p> <p><i>TSO 5b.</i> Differentiate between recursive and iterative domain name resolution.</p> <p><i>TSO 5c.</i> Explain the concept of remote logging using TELNET.</p> <p><i>TSO 5d.</i> Explain the roles of User Agent, Message Transfer Agent (SMTP), and Message Access Agent (POP and IMAP).</p> <p><i>TSO 5e.</i> Explain function of File Transfer Protocol (FTP) for file transfer.</p> <p><i>TSO 5f.</i> Differentiate between HTTP persistent and non-persistent connections.</p> <p><i>TSO 5g.</i> Explain the role of proxy servers in HTTP.</p> <p><i>TSO 5h.</i> Explain the functioning of DHCP</p>	<p><b>Unit 5.0 Application Layer</b></p> <p>5.1 <b>Distribution of name space:</b> Hierarchy of Name Servers, Root Server, Primary and Secondary Servers</p> <p>5.2 <b>DNS in the internet:</b> - Generic Domains, Country Domains, Inverse Domain</p> <p>5.3 <b>Resolution:</b> -Resolver, Mapping Names to Addresses, Mapping Address to Names, Recursive Resolution, Iterative Resolution, Caching</p> <p>5.4 <b>WWW:</b> - ARCHITECTURE, Client (Browser), Server, Uniform Resource Locator, Cookies</p> <p>5.5 <b>HTTP:</b> -HTTP Transaction, Persistent Versus Nonpersistent Connection, Proxy Server</p> <p>5.6 <b>Dynamic Host Configuration Protocol (DHCP)</b></p> <p>5.7 <b>Remote logging:</b> - TELNET</p> <p>5.8 <b>Electronic mail:</b> - ELECTRONIC MAIL, Architecture, User Agent, Message Transfer Agent: SMTP, Message Access Agent: POP and IMAP, Web-Based Mail</p> <p>5.9 <b>File transfer:</b> -File Transfer Protocol (FTP)</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: P2418501

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
<p>LSO1.1 Recognize different Networking devices such LAN adapter, Hub, Switches, Routers.</p> <p>LSO1.2 Prepare the UTP cable for cross and direct connection.</p>	1.	<p>1.1 Identify different Networking devices</p> <p>1.2 Prepare different types of UTP cable</p>	CO-1
<p>LSO2.1 Create Star topology using network devices, cables, and Computers.</p> <p>LSO2.2 Configure wireless NIC and transfer files between systems in Wireless</p>	2.	<p>2.1 Create a network using Star topology.</p> <p>2.2 Configure wireless NIC and transfer files between systems in Wireless network.</p>	CO-2
<p>LSO3.1 Configure Host IP, Subnet Mask and Default Gateway in a System.</p> <p>LSO3.2 Establish Peer to Peer network connection without Switch.</p>	3.	<p>3.1 Configure IP address using Network and Internet Setting in windows.</p> <p>3.2 Establish Peer to Peer network connection using cross cable.</p>	CO-3

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
LSO.4.1 Capture packet and analysis header using network simulator. LSO.4.2 Configure Telnet Settings.	4	4.1 Capture packet and analysis header using network simulator. 4.2 Perform remote login using Telnet.	CO-4
LSO.5.1 Create HTTP server LSO.5.2 Create FTP server	5.	5.1 Create HTTP sever 5.2 Create FTP server	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: S2418501

- 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 basic chat application that allows users to communicate over a local network.
  2. Create a tool that monitors network bandwidth usage in real-time.
  3. Create a simple remote desktop application that allows users to control a computer remotely over the network.
- c. **Other Activities:**
  1. Use network simulation tools like Cisco Packet Tracer, GNS3, or NS-3 to create and simulate network scenarios
  2. Use packet capturing tools like Wireshark to capture and analyze network traffic in real-time.
  3. Join online CTF challenges related to network security.
  4. Study the function of all layers in TCP/IP suit.
  5. Study all protocols of all layers of TCP/IP Suit.
- d. **Self-Learning Topics:**
  1. Learn about the virtualization of network functions, transforming traditionally hardware-based network functions into software.
  2. Explore advanced concepts in QoS and QoE, including techniques for ensuring a high-quality user experience in networked applications.
  3. Learn socket programming for process to process communication.
  4. Learn different routing protocols.

- I) **Course Curriculum Detailing:** 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: T2418502**

Major Theory Session Outcomes (TSOs)	Units	Relevant Cos Number(s)
<p><i>TSO 1a.</i> Identify the attributes that matches with standards for the given software application.</p> <p><i>TSO 1b.</i> Suggest the relevant software solution for the given problem with justification.</p> <p><i>TSO 1c.</i> Select the relevant software process model for the given problem statement.</p> <p><i>TSO 1d.</i> Select the relevant activities in agile development process in the given situation.</p>	<p><b>Unit-1.0 Software Development Process</b></p> <p>1.1 Type of software, need for software engineering, software engineering as layered approach, its characteristics.</p> <p>1.2 Software development frame work.</p> <p>1.3 Software process framework, process models: perspective process models, specialized process models.</p> <p>1.4 Agile software development: agile process and its importance, extreme programming, adaptive software development, scrum, dynamics system development method (DSDM), crystal</p> <p>1.5 Selection criteria for software process model.</p>	<b>CO-1</b>
<p>TSO.2.a Apply the principles of software engineering for the given problem</p> <p>TSO.2.b Analyze software requirement by following requirement engineering steps for the given problem.</p> <p>TSO.2.c Represent the requirement engineering model for the given problem</p> <p>TSO.2.d Prepare SRS for the given problem.</p>	<p><b>Unit 2.0 Software Requirement Engineering</b></p> <p>2.1 Software engineering practices and its importance, core Principles.</p> <p>2.2 Communication practices, planning practices, modeling Practices. Construction practices, software deployment (Statement and meaning of each Principles for each practice).</p> <p>2.3 Requirement Engineering: Requirement gathering and Analysis, type of requirement (functional, product, organizational, external requirements) Electing requirements models, developing use cases building requirements models, requirement negotiation, validation.</p> <p>2.4 Software Requirements Specification (SRS): need of SRS, Format, and its characteristic</p>	<b>CO-2</b>
<p>TSO.3.a Identify the elements of analysis model for the given software requirements.</p> <p>TSO.3.b Apply the specified design feature for software requirements modeling.</p> <p>TSO.3.c Represent the specified problem in the given design notation.</p>	<p><b>Unit 3.0 Software Modeling and Design</b></p> <p>3.1 Translating requirement model into design model: data Modelling.</p> <p>3.2 Analysis Modelling: Elements of Analysis model.</p> <p>3.3 Design modelling: Fundamental design concept (Abstraction, Information hiding,</p>	<b>CO-3</b>

Major Theory Session Outcomes (TSOs)	Units	Relevant Cos Number(s)
	structure, modularity, concurrency, verification, Aesthetics) 3.4 Design notations: Data Flow Diagram (DFD), Structure Flowcharts, Decision Tables.	
TSO.4.a Estimate the size of the software product using the given method. TSO.4.b Estimate the cost of the software product using the given empirical method. TSO.4.c Evaluate the size of the given software using COCOMO model. TSO.4.d Apply the RMMM strategy in identified risks for the given software development problem.	<b>Unit-4.0 Software Project Estimation</b>  4.1 The management spectrum-4P's 4.2 Metrics for size Estimation: Line of Code (LoC), Function Points (FP). 4.3 Project cost Estimation Approaches: Overview of Heuristic, Analytical, and Empirical Estimation. 4.4 COCOMO (Constructive Cost Model), COCOMO II. 4.5 Risk Management: Risk Identification, Risk Assessment, Risk Containment, RMMM Strategy.	<b>CO-4</b>
TSO.5.a Explain the given characteristic of software testing. TSO.5.b Prepare test cases for the given problem. TSO.5.c Analyze the test cases for a given problem. TSO.5.d Describe the given Software Quality Assurance (SQA) activity. TSO.5.e Describe the features of the given software quality evaluation standard.	<b>Unit 5.0 Software Testing and Quality Assurance:</b>  5.1 Testing-Meaning and purpose, testing methods- Black- box and White box, level of testing-Unit testing. 5.2 Test Documentation- Test case Template, test plan, Introduction to defect Report, test summary report. 5.3 Test planning and management: Test Strategy, Test Plan, Test Estimation, Test Case Design, Test Data Preparation, Test Progress Monitoring and Reporting. 5.4 Software Quality Management vs. Software Quality Assurance. Phases of Software Quality Assurance: Planning, Activities Audit, and review. 5.5 Quality Evaluation standards: Six sigma, ISO for software, CMMI: Levels, process areas.	<b>CO-5</b>
TSO.6.a Use the given scheduling technique for the identified project. TSO.6.b Draw the activity network for the given task. TSO.6.c Prepare the timeline chart/Gantt chart to track progress of the given project.	<b>Unit 6.0 Software Project Management</b>  6.1 Overview of project management activities, tasks, resources, Project Scheduling: Basic principle work breakdown structure, activity network and critical path method, scheduling Techniques (CPM, PERT). 6.2 Project Tracking; Timeline Charts. Earned value analysis, Gantt charts.	<b>CO-6</b>

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**J) Theory Session Outcomes (TSOs) and Units: T2418503A**

Major Theory Session Outcomes (TSOs)	Units	Relevant Cos Number(s)
TSO1.a Identify various data collection methods and sources in data science. TSO1.b Explain the various data types and data structures used in data science. TSO1.c Differentiate between data types and data structures in data science. TSO1.d List different statistical methods used in data science for data analysis. TSO1.e Explain the principle of Hypothesis Testing TSO1.f Compare the methodologies of various Forecasting techniques.	<b>Unit-1.0 Data Science: Concepts and Techniques</b>  1.1 Concepts and Importance 1.2 Data Types and Data Structures in Data Science 1.3 Data Collection and Data Sources in Data Science 1.4 Exploratory Data Analysis (EDA) 1.5 Statistical Methods for Data Analysis in Data Science <ul style="list-style-type: none"> <li>• Descriptive Analysis</li> <li>• Exploratory Analysis</li> <li>• Inferential Analysis</li> <li>• Predictive Analysis</li> <li>• Linear Regression</li> <li>• Logistic Regression</li> </ul> 1.6 Probability and Probability Distributions in Data Science 1.7 Hypothesis Testing 1.8 Forecasting Techniques <ul style="list-style-type: none"> <li>• Delphi</li> <li>• Input Output Analysis</li> <li>• Extrapolation</li> <li>• Time Series analysis</li> </ul> 1.9 Data Ethics and Privacy in Data Science	<b>CO-1</b>
TSO2.a Explain the need for a separate data warehouse in the context of data storage and retrieval. TSO2.b Differentiate between the various Data Warehouse Models. TSO2.c Explain the benefits of data warehousing in terms of data management and decision-making. TSO2.d List the benefits of OLAP in analytical tasks. TSO2.e Differentiate between OLAP and data mining.	<b>Unit-2.0 Data Warehousing and On-Line Analytical Processing</b>  2.1 Definition of Data Warehouse 2.2 Need for separate data warehouse 2.3 Data Warehouse Models: <ul style="list-style-type: none"> <li>• Enterprise Warehouse</li> <li>• Data Mart</li> <li>• Virtual Warehouse</li> </ul> 2.4 Difference between Operational Database System and Data Warehouse 2.5 Conceptual Modeling of Data Warehouse 2.6 Data warehouse architecture 2.7 Benefits of data warehousing 2.8 Introduction to Online Analytical Processing	<b>CO-2</b>

Major Theory Session Outcomes (TSOs)	Units	Relevant Cos Number(s)
	2.8.1 OLAP applications 2.8.2 Features of OLAP 2.8.3 Benefits of OLAP 2.8.4 Strengths of OLAP 2.8.5 Comparison between OLTP and OLAP 2.8.6 Differences between OLAP and data mining 2.9 OLAP Operations (Roll-up, Drill down, Slice and dice) 2.10 Data Cube Computation 2.11 Data warehouses versus OLTP: similarities and distinction	
TSO 3a. Explain the fundamental concepts of data mining. TSO 3b. Explain the significance of data mining and its applications in solving real- world problems. TSO 3c. List various data mining techniques. TSO 3d. Explain the importance of data preprocessing and major tasks involved in data preprocessing. TSO 3e. List steps to integrate a data mining system with a database. TSO 3f. Explain major issues in data mining. Differentiate between operational database systems and data warehouses.	<b>Unit 3.0 Introduction to Data Mining</b> 3.1 Introduction 3.2 Data Mining as Evolution of Information Technology 3.3 Types of data for mining <ul style="list-style-type: none"> <li>• Database Data</li> <li>• Data Warehouses</li> <li>• Transactional Data</li> <li>• Other types of data</li> </ul> 3.4 Need of Data Mining 3.5 Data Mining Application 3.6 Data Preprocessing <ul style="list-style-type: none"> <li>3.6.1 Need for Data Preprocessing</li> <li>3.6.2 Major Tasks in Data Preprocessing</li> <li>3.6.3 Data Preprocessing Methods               <ul style="list-style-type: none"> <li>• Data cleaning</li> <li>• Data integration</li> <li>• Data transformation</li> <li>• Data reduction</li> <li>• Data Discretization</li> </ul> </li> </ul> 3.7 Data Mining Techniques <ul style="list-style-type: none"> <li>• - Predictive modeling Database segmentation</li> <li>• Link analysis</li> <li>• Deviation detection</li> </ul> 3.8 Integration of a Data Mining System with Database 3.9 Major Issues in Data Mining	<b>CO-3</b>
TSO 4a. Explain the approaches used to solve classification problems including the steps involved in the process. TSO 4b. Explain the evaluation of classifiers using appropriate techniques to assess their performance. TSO 4c. Explain different classification metrics such as accuracy, precision, recall. TSO 4d. Explain the concept of pattern- based	<b>Unit 4.0 Classification Methods</b> 4.1 Introduction to Classification 4.2 Approach to solve classification problems 4.3 Evaluation of Classifiers 4.4 Classification Metrics 4.5 Types of Classification <ul style="list-style-type: none"> <li>4.5.1 Posteriori Classification</li> <li>4.5.2 Priori Classification</li> <li>4.5.3 Binary Classification</li> </ul>	<b>CO-4</b>

Major Theory Session Outcomes (TSOs)	Units	Relevant Cos Number(s)
<p>classification.</p> <p>TSO 4e. Explain the characteristics of lazy learners in classification.</p> <p>TSO 4f. Give examples of real-world applications of classification.</p>	<p>4.5.4 Multi-class Classification</p> <p>4.6 Classification Techniques</p> <p>4.6.1 Bayesian Classification</p> <p>4.6.2 Support Vector Machine</p> <p>4.6.3 Decision Tree</p> <p>4.6.4 Dimensionality Reduction</p> <p>4.7 Pattern Based Classification</p> <p>4.8 Over-fitting and Under-fitting</p> <p>4.9 Lazy Learners</p> <p>4.10 Applications of Classification</p>	
<p>TSO 5a. Identify the requirements for conducting cluster analysis.</p> <p>TSO 5b. Explain the various applications of cluster analysis in real-world scenarios.</p> <p>TSO 5c. Explain different basic clustering methods, including partitioning, hierarchical, and density-based methods.</p> <p>TSO 5d. Differentiate between agglomerative and divisive hierarchical clustering techniques.</p> <p>TSO 5e. Explain the techniques for identifying and handling outliers in cluster analysis.</p> <p>TSO 5f. Explain the role of web mining in extracting valuable information from different web-based sources.</p>	<p><b>Unit 5.0: Cluster Analysis and Web Mining</b></p> <p>5.1 Introduction to Cluster Analysis</p> <p>5.2 Requirements for cluster analysis</p> <p>5.3 Applications of Cluster Analysis</p> <p>5.4 Overview of basic clustering methods</p> <p>5.5 Major Clustering Methods</p> <p>5.5.1 Partitioning Based</p> <ul style="list-style-type: none"> <li>• k-Means Clustering- A Centroid-Based Technique</li> </ul> <p>5.5.2 Hierarchical Based</p> <ul style="list-style-type: none"> <li>• Agglomerative</li> <li>• Divisive</li> </ul> <p>5.5.3 Density Based</p> <ul style="list-style-type: none"> <li>• DBSCAN: Density-Based Clustering Based on Connected</li> </ul> <p>5.6 Agglomerative versus Divisive Hierarchical Clustering</p> <p>5.7 Distance Measures in Algorithmic Methods</p> <p>5.8 Applications of Cluster Analysis</p> <p>5.9 Identifying and handling of outliers</p> <p>5.10 Outlier Detection Techniques</p> <p>5.11 WEB MINING: Basic concepts</p> <p>5.12 PAGE RANK Algorithm</p> <p>5.13 HITS Algorithm</p>	<p><b>CO-5</b></p>

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

**K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2418503A**

Practical/Lab Session Outcomes (LSOs)	S. No	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
<p>LSO 1.1 List the necessary data preprocessing methods</p> <p>LSO 1.2 Identify the suitable datasets for using as input in linear regression and logistic regression.</p> <p>LSO 1.3 Calculate the efficiency of the various algorithms used for statistical analysis.</p>	1.	<p>1.1 Practice the necessary basic functions to handle the dataset.</p> <p>1.2 Perform the statistical analysis by using linear regression and logistic regression on suitable dataset. Conduct the time using different sizes of datasets.</p> <p>1.3 Perform the statistical analysis by using logic regression on suitable datasets. Conduct the time using different sizes of datasets.</p>	CO-1
<p>LSO 2.1 Explain the OLAP operations with suitable examples.</p> <p>LSO 2.2 Explain the OLAP cube construction process with necessary steps.</p> <p>LSO 2.3 List the OLAP queries for any data.</p> <p>LSO 2.4 Differentiate the OLTP and OLAP queries and operations.</p>	2.	<p>2.1 Perform the necessary OLAP Operations</p> <p>2.2 Demonstrate the OLAP Cube construction</p> <p>2.3 Apply the OLAP Queries on suitable input.</p> <p>2.4 Demonstrate the OLTP using a dataset</p>	CO-2
<p>LSO 3.1 Explain the data pre-processing tasks</p> <p>LSO 3.2 Explain the attribute reduction in a dataset</p> <p>LSO 3.3 Handle the missing values in a dataset.</p> <p>LSO 3.4 Explain the data segmentation</p>	3.	<p>3.1 Perform the following data pre-processing tasks using a dataset.</p> <ul style="list-style-type: none"> <li>• Data cleaning</li> <li>• Data integration</li> </ul> <p>3.2 Perform the following data pre-processing tasks using a dataset.</p> <ul style="list-style-type: none"> <li>• Data reduction</li> <li>• Data transformation</li> </ul> <p>3.3 Pre-process a given dataset based on Attribute selection</p> <p>3.4 Pre-process a given dataset based on Handling Missing Values</p> <p>3.5 Perform data segmentation on a dataset</p>	CO-3
<p>LSO 4.1 Identify the suitable datasets for demonstrating the various algorithms</p> <p>LSO 4.2 Explain the Apriori algorithm.</p> <p>LSO 4.3 Explain the FP-Growth</p> <p>LSO 4.4 Calculate the Information Gain Ratio</p> <p>LSO 4.5 Explain the Bayesian Classifier</p> <p>LSO 4.6 Explain the Decision Tree</p> <p>LSO 4.7 Explain the SVM</p>	4	<p>4.1 Implement the Apriori algorithm.</p> <p>4.2 Implementation of FP-Growth</p> <p>4.3 Calculate the Information Gain Ration for the input dataset</p> <p>4.4 Implementation of Bayesian Classifier</p> <p>4.5 Implementation of Decision Tree</p> <p>4.6 Implementation of SVM</p> <p>4.7 Demonstrate the pattern based classification</p>	CO-4
<p>LSO 5.1 Identify the suitable datasets for demonstrating the various algorithms</p> <p>LSO 5.2 Explain the k-means clustering algorithm</p> <p>LSO 5.3 Explain the DBSCAN algorithm</p>	5.	<p>5.1 Implement the K-Means clustering algorithm on a dataset</p> <p>5.2 Implement the DBSCAN algorithm on a dataset</p>	CO-5

Practical/Lab Session Outcomes (LSOs)	S. No	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
LSO 5.4 Differentiate the k-Means and DBSCAN LSO 5.5 Explain the Hierarchical clustering algorithm LSO 5.6 Explain the page ranking algorithm LSO 5.7 Explain the HITS algorithm	.	5.3 Implement the Hierarchical algorithm on a dataset 5.4 Implement the Page Ranking algorithm 5.5 Implement the HITS algorithm	

### L) Suggested Term Work and Self Learning: S2418503A

- a. **Assignments:** Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.
1. Differentiate the Linear Regression and Logistic Regression with examples.
  2. Explain the role of time series analysis in the process of forecasting.
  3. Explain in detail about the hypothesis testing with suitable example.
  4. Explain the OLAP operations by using a database.
  5. Demonstrate the data cube operation by using a real time dataset.
  6. Write the importance of the data pre-processing methods over the decision-making process on any dataset. Justify it.
  7. Differentiate the posterior classification and priori classification with suitable examples.
  8. Construct a decision tree for forecasting the Weather of the city in future.
  9. Differentiate the agglomerative clustering and divisive clustering with suitable examples.
  10. Write the advantages and disadvantages of the k-Means clustering and DBSCAN algorithm.
- b. **Micro Projects: Troubleshooting and Maintenance of a Classroom Computer Lab**
1. Social Network Analysis: Analyze a social network dataset to understand network structure, identify influential nodes, or detect communities within the network.
  2. Clustering:
    - a. k-Means Clustering: Apply the K-Means clustering algorithm to group data points into clusters. Experiment with different values of K to understand its impact.
    - b. Hierarchical Clustering: Implement hierarchical clustering on a dataset, visualize dendrograms, and analyze the results.
  3. Classification:
    - a. Decision Trees: Build a decision tree model for classification using a popular dataset like the Iris dataset. Evaluate the model's accuracy, and visualize the decision tree.
    - b. Support Vector Machines (SVM): Use SVM to classify data points into different classes. Experiment with different kernels (linear, radial basis function) and tune hyper-parameters.
  4. Web Scraping and Data Extraction: Write a Python script to scrape data from a website. Extract relevant information and store it in a structured format (e.g., CSV, Excel). Apply basic data cleaning techniques to the extracted data.
  5. Use a classification dataset and implement machine learning algorithms like decision trees, Random forests, or support vector machines to classify data points. Evaluate the models using metrics like accuracy, precision, recall, and F1-score

- 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: T2418503B**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1a.</i> Explain concept of applet life cycle.</p> <p><i>TSO 1b.</i> Differentiate between applet and application.</p> <p><i>TSO 1c.</i> Develop code for simple java applets.</p> <p><i>TSO 1d.</i> Use applet tag and its parameter.</p> <p><i>TSO 1e.</i> Use the methods of the applet and component classes.</p>	<p><b>Unit-1.0 JAVA Applet</b></p> <p>1.1 Applet: Local and remote applets, Difference between applet and application, Applet life cycle, Developing executing applet code</p> <p>1.2 Web page design: Applet tag, Adding applet to HTML file, Passing parameter to applet, Various methods and component classes to develop basic applet, Running applet.</p> <p>1.3 Applet graphics: Drawing shapes and text, Handling graphics in applets, Animation with applets.</p>	CO-1
<p><i>TSO 2a.</i> Explain the fundamental concepts of windows in AWT.</p> <p><i>TSO 2b.</i> Compare AWT and Swing for developing graphical user interfaces.</p> <p><i>TSO 2c.</i> Differentiate between various event classes in AWT.</p> <p><i>TSO 2d.</i> List the advantages and disadvantages of different layout managers.</p> <p><i>TSO 2e.</i> Explain the role and purpose of event listener interfaces.</p> <p><i>TSO 2f.</i> Create an event-handling mechanism using event listener interfaces.</p>	<p><b>Unit-2.0 Abstract Window Toolkit (AWT)</b></p> <p>2.1 Abstract Window Toolkit: Class hierarchy, Window fundamentals</p> <p>2.2 Frame Window: Creating a frame window in the applet, Canvas, Creating a window program</p> <p>2.3 Graphics-AWT Controls: Labels, TextField, Pushbuttons</p> <p>2.4 Layout Managers: Flow Layout, Border Layout, Grid Layout, Card Layout</p> <p>2.5 Developing Graphical User Interface using Swing: JApplet, JLabel, JTextField, JButton, JCheckBox, JRadioButton, JComboBox, Menus</p> <p>2.6 Event Classes: MouseEvent Class, ActionEvent Class, WindowEvent Class</p> <p>2.7 Event Listen Interface: MouseListener, ActionListener, WindowListener and KeyListner</p>	CO-2
<p><i>TSO 3a.</i> Describe the basics of JDBC and its connectivity.</p>	<p><b>Unit-3.0 Java Data Base Connectivity (JDBC)</b></p> <p>3.1 JDBC Architecture: Two-Tier Database Design, Three-Tier Database Design</p>	CO-3

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 3b.</i> Explain the key components of the JDBC API and their functions.</p> <p><i>TSO 3c.</i> Compare different types of JDBC drivers.</p> <p><i>TSO 3d.</i> Develop Java code to work with JDBC statements.</p> <p><i>TSO 3e.</i> Explain the process of managing connections and resources in JDBC.</p> <p><i>TSO 3f.</i> Implement transactions in JDBC, including both auto-commit and manual transaction management.</p> <p><i>TSO 3g.</i> List the advantages and disadvantages of JDBC.</p>	<p>3.2 The JDBC API: The API components, Database operation: creating tables, CRUD (Create, Read, Update, and Delete) operations using SQL.</p> <p>3.3 Establishing a JDBC Connection: JDBC Data Types, JDBC drivers, Connection management and resource cleanup, JDBC- Statements, PreparedStatement and CallableStatement, JDBC- ResultSet, JDBC- Transactions, JDBC- Exception Handling.</p> <p>3.4 JDBC- Advantages and Disadvantages</p>	
<p><i>TSO 4a.</i> Describe life cycle of servlet.</p> <p><i>TSO 4b.</i> Explain the purpose and key features of the javax.servlet package.</p> <p><i>TSO 4c.</i> Differentiate between the javax.servlet and javax.servlet.http packages.</p> <p><i>TSO 4d.</i> Explain the components and purpose of the Java Servlet Development Kit (SDK).</p> <p><i>TSO 4e.</i> Create a servlet that serves specific web application functionality.</p> <p><i>TSO 4f.</i> Evaluate the benefits and drawbacks of using servlets for web development</p>	<p><b>Unit-4.0 Servlets Programming</b></p> <p>4.1 Servlet API</p> <p>4.2 javax.servlet Package</p> <p>4.3 The javax.servlet. HTTP Package</p> <p>4.4 The life cycle of a servlet</p> <p>4.5 The Java Servlet Development Kit</p> <p>4.6 The Simple Servlet: Create and compile servlet source code, Start a web browser and request the servlet, Example of echo servlet, Deployment in Tomcat server, Handling HTTP Requests and Responses</p>	<b>CO-4</b>
<p><i>TSO 5a.</i> Explain the architecture of JSP and its Life-cycle.</p> <p><i>TSO 5b.</i> Differentiate between various JSP implicit objects.</p> <p><i>TSO 5c.</i> Develop simple programs using Java Server Pages tags</p> <p><i>TSO 5d.</i> Write JSP expressions to display dynamic content within a web page.</p> <p><i>TSO 5e.</i> Create JSP pages using action tags to implement various functionalities.</p> <p><i>TSO 5f.</i> Implement a JSP program that fetches and displays database records.</p>	<p><b>Unit-5.0 Java Server Pages (JSP)</b></p> <p>5.1 Relation of Applets and Servlets with JSP</p> <p>5.2 Lifecycle of JSP</p> <p>5.3 JSP Scripting Elements</p> <p>5.4 JSP Implicit Objects: Implicit objects- example of out and request, Response implicit object, PageContext, page and exception implicit object</p> <p>5.5 JSP Expressions</p> <p>5.6 JSP Action Tags</p> <p>5.7 JSP Declarations</p> <p>5.8 JSP- Standard Tag Library (JSTL)</p> <p>5.9 Difference between JSP and Servlet</p> <p>5.10 Simple JSP program to fetch database records</p>	<b>CO-5</b>

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

**K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2418503B**

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<p><i>LSO 1.1.</i> Implementation of Applet for</p> <p>a) displaying clock</p> <p>b) Filling colors in the shape</p> <p>c) Creating an event listener</p> <p>d) Displaying image</p>	1.	<p>a) Write a program to display clock using Applet.</p> <p>b) Write a program to fill colors in shapes using Applet.</p> <p>c) Write a program to create an event listener in Applet.</p> <p>d) Write a program to display image using Applet.</p>	CO-1
<p><i>LSO 2.1.</i> Use AWT components to create Label, textfield, textarea, button, checkbox, radiobutton.</p> <p><i>LSO 2.2.</i> Create a form using Component list and choice.</p> <p><i>LSO 2.3.</i> Create a simple calculator by using grid layout.</p>	2.	<p>a) Write a program for using the following awt components: Label, text field, text area, button, checkbox, radio button.</p> <p>b) Write a program to design a form using the components list and choice.</p> <p>c) Write a program to design a simple calculator by using grid layout.</p>	CO-2
<p><i>LSO 3.1.</i> Create a program to</p> <p>a) Connect with JDBC database.</p> <p>b) Insert values into Table.</p> <p>c) Delete values from Table.</p>	3.	<p>a) Write a java program that connects to a database using JDBC.</p> <p>b) Write a java program to connect to database using JDBC &amp; insert values into table.</p> <p>c) Write a java program to connect to a database using JDBC and delete values from table.</p>	CO-3
<p><i>LSO 4.1.</i> Illustrate counter concept using deployment descriptor.</p> <p><i>LSO 4.2.</i> Create a web form which process servlet and apply concept of cookies and sessions.</p>	4.	<p>a) Write a simple servlet program which maintains a counter for the number of times it has been accessed since its loading; initialize the counter Using deployment descriptor.</p> <p>b) Create a web form which processes servlet and demonstrates use of Cookies and sessions.</p>	CO-4
<p><i>LSO 5.1.</i> Illustrate the concept of JSP for developing web pages.</p>	5.	<p>a) Write a simple JSP program for user registration and then control will be transfer it into second page.</p> <p>b) Write a simple JSP program for user login form with static and dynamic database</p> <p>c) Write a JSP program to display the grade of a student by accepting the marks of five subjects.</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.

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: T2400504B**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
TSO 1a. Elaborate the use of ArtificialIntelligence TSO 1b. Explain various technological Driversof Modern AI TSO 1c. Describe Knowledge representation TSO 1d. Classify Intelligent agents TSO 1e. List the characteristics of agents TSO 1f. Apply various search strategies for problem solving	<b>Unit-1.0. Artificial Intelligence</b>  <b>Artificial Intelligence:</b> What is AI?, Types of AI, History of AI, Turing Test, Symbol Systems and the scope of Symbolic AI, Structure of AI, Goals of AI, Importance ofAI, Techniques used in AI, Perception, Understanding and Action, Technological drivers of modern AI <b>Knowledge:</b> Definition, Knowledge Representation, objectives andrequirements, practical aspects of representation, Components <b>Intelligent Agents:</b> Agents and Environments, Properties of environments,characteristics of agents, classification of agents <b>Problem Solving:</b> Problem Formulation,Goal Formulation, State Space Search,Search Problem, Basic search algorithm,Search Tree, Search strategies–Uninformed and informed search, Breadth FirstSearch, Depth FirstSearch, Best FirstSearch, Constraint Satisfaction Problem (CSP), Back tracking Search.Problem Definitions: N Queen Problem, 8Puzzle Problem, Tic-tac-Toe.	CO-1
TSO 2a. Explain Python tokens and variables TSO 2b. Use the concept of l-value and r -value TSO 2c. Write python program using various data types TSO 2d. Write Program using variousoperators in Python TSO 2e. Write program using conditional statements TSO 2f. Use various string functions for problem solving in python program TSO 2g. Write programmes using various operations on list TSO 2h. Write programmes by using various operations on Tuples and Dictionary TSO 2i. Create user defined functions TSO 2j. Write python programmes using built-in functions TSO 2k. Describe the procedure to import module in the Python	<b>Unit-2.0 Python Programming</b>  Python character set, Python tokens, variables, concept of l-value and r-value,use of comments. Data types: number (integer, floating point, complex), boolean, sequence (string,list, tuple), none, mapping (dictionary), mutable and immutable data types Operators: arithmetic operators, relationaloperators, logical operators, assignmentoperator, augmented assignmentoperators. Expressions, statement, typeconversion & input/output: precedence ofoperators, expression, evaluation ofexpression. <b>Conditional and Iterative statements:</b> if, if-else, if-elif-else, for loop, range function, while loop, break and continue statements, nested loops <b>String, List, Tuples and Dictionary:</b> String: indexing, string operations (concatenation,	CO-2

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
<p>TSO 2l. Describe procedure to Import Library and functions in the Python</p> <p>TSO 2m. Write program using Iterative statements.</p>	<p>repetition, membership &amp; slicing), traversing a string using loops, built-in functions.</p> <p>Lists: introduction, indexing, list operations (concatenation, repetition, membership &amp; slicing), traversing a list using loops, built-in functions, linear search on list of numbers and counting the frequency of elements in a list</p> <p>Dictionary: accessing items in a dictionary using keys, mutability of dictionary (adding a new item, modifying an existing item), traversing a dictionary, built-in functions</p> <p><b>Python Functions:</b> types of function (built-in functions, functions defined in module, user defined functions), creating user defined function, arguments and parameters, default parameters, positional parameters, function returning value(s), flow of execution, scope of a variable (global scope, local scope)</p> <p><b>Modules and Packages:</b> Importing module using 'import' Regular Expressions, Exception Handling, PyPI Python Package Index, Pip Python package manager, Importing Libraries and Functions</p>	
<p>TSO 3a. Explain Data Analytics and its elements</p> <p>TSO 3b. Differentiate Data Analysis and Data Analytics</p> <p>TSO 3c. Explain the use of open source data</p> <p>TSO 3d. Differentiate Qualitative and Quantitative data analysis</p> <p>TSO 3e. Explain procedure to Install NumPy Library</p> <p>TSO 3f. Use NumPy library to perform various operations and functions on array</p> <p>TSO 3g. Write Programs using NumPy for array manipulations</p>	<p><b>Unit-3.0 Data Analytics and Computing with NumPy</b></p> <p><b>Data Analytics:</b> Data, Types of Data, Importance of Data, Data Analysis Vs Data Analytics, Types of Data Analytics, Elements of Analytics, Data Analysis Process, Qualitative and Quantitative analyses, Open Source Data.</p> <p><b>NumPy Library:</b> Introduction, Installation,</p> <p><b>Ndarray:</b> creating an array, intrinsic creation of an array, Data types, basic operations, aggregate functions, Indexing, slicing, Iterating, Conditions and Boolean arrays, Array</p> <p><b>manipulation:</b> Joining, splitting, shape changing, sorting, Structured arrays, Reading and Writing array data on a File.</p>	<b>CO-3</b>
<p>TSO 4a. Apply Pandas data structure for data analysis</p> <p>TSO 4b. Write Programs using Pandas to perform various operations and functions on series.</p> <p>TSO 4c. Perform various operation in a Data Frame columns and rows</p> <p>TSO 4d. Write Programme to read and write on CSV, XLS and Text data files</p> <p>TSO 4e. Apply various data cleaning operations and prepare data.</p>	<p><b>Unit-4.0 Data Analysis with Pandas</b></p> <p><b>Pandas data structures:</b> Series, Declaration, selecting elements, assigning values, Filtering values, operations, mathematical functions, evaluating values, handling missing data, creating series from dictionaries, adding two series.</p> <p><b>Data Frame:</b> Defining, selecting elements, assigning values, membership, deleting a column, filtering. Index Objects: Indexing, Re-indexing, Dropping, sorting and ranking, Descriptive Statistics</p> <p><b>Data Loading:</b> Reading and Writing csv, xls, text data files, Data Cleaning and Preparation: Handling missing data, removing duplicates, replacing values, Vectorized String Methods,</p>	<b>CO-4</b>

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
	Hierarchical Indexing, Merging and Combining, Data aggregation and Grouping.	
TSO 5a. Illustrate the use of Matplotlib and PyPlot package for showing plots and images TSO 5b. Customize plots with Colors, Markers, Line Styles, Limits, Tics, Labels, Legends, Grids TSO 5c. Differentiate various charts based on their applications	<b>Unit-5.0 Data Visualization with Matplotlib</b>  Data Visualization: Introduction to Matplotlib ,PyPlot package, Figures and Subplots, showing plots and images Customizing Plots: Colors, Markers, Line Styles, Limits, Tics, Labels, Legends, Grids ,Annotating with text, Matplotlib  Configuration Chart types: Line, Bar, stacked bar, Box plots, pie chart , Histogram and Density plots, Scatter plot, Saving Plots to a file,  Close and clear plots.	<b>CO-5</b>

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

### K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400504B

Practical/ Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
LSO 1.1 Use various data types and operators to solve given problem LSO 1.2 Use conditional and iterative statements for solving given problem	1	<b>Conditional and Iterative statements</b> 1a. Write a program to generate random numbers between 5 and 10. 1b. Write a program to find the square root of a number. 1c. Write a python program to check if a number is positive, negative or 0. 1d. Write Python program to print all prime numbers between 0-50.	CO-2
LSO 2.1 Use string functions for performing various string operations	2	<b>String Handling</b> 2a. Write a Programme that asks the user for a string with only single space between words, and return number of words in the string. 2b. Write a Program that inputs a line of text and print the count of Vowels in it. 2c. Write a Program that inputs a line of text and print the biggest word in it. 2d. Write a Program that inputs a line of text and print a new line of text where each word of input line is reversed.	CO-2
LSO 3.1 Use list operations for concatenation, repetition & slicing LSO 3.2 Perform various operation in the Tuples LSO 3.3 Perform various operation in the dictionary	3	<b>List, Tuples and Dictionary</b> 3a. Write a python program to convert a string to a list. 3b. Write a program to print the largest number in a list. 3c. Given a tuple pairs = ((3,9), (8,4), (3,7), (24,18)), count the number of pairs (a, b) such that both a and b are odd. 3d. Write a program to input a list of numbers and swap elements at the even location with the elements at the odd location.	CO-2

Practical/ Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
		3e. Write a program to merge two dictionaries.	
LSO 4.1 Use built-in functions to solve given problem LSO 4.2 Create user defined functions to solve given problem	4	<b>Python Functions</b> 4a. Write a function to reverse a string. 4b. Write a function to calculate the factorial of a number.	CO-2
LSO 5.1 use basic data structure using NumPy LSO 5.2 Convert the list and tuple as NumPy array	5.	<b>Basic data structures in NumPy</b> 5a. Create a List, set, tuple and dictionary which stores the details of a student (roll no, name, dept, branch, percentage of mark) in Python and print the values. 5b. Convert the list and tuple as NumPy array.	CO-3
LSO 6.1 Create Arrays in Numpy using different intrinsic methods LSO 6.2 Perform arithmetic operations and mathematical operations using arrange and ones intrinsic method.	6	<b>Arrays in NumPy</b> 6a. Create arrays using different intrinsic methods (ones, zeros, arange, linspace, indice) and print their values. 6b. Check the results of arithmetic operations like add(), subtract(), multiply() and divide() with arrays created using arrange and ones intrinsic method. 6c. Check the results of mathematical operations like exp(), sqrt(), sin(), cos(), log(), dot() on an array created using arrange intrinsic method.	CO-3
LSO 7.1 Apply aggregate functions on data by using Built-in function s in Numpy	7	<b>Built-in functions in NumPy.</b> 7a. Load your class Mark list data from a csv (comma separated value) file into an array. Perform the following operations to inspect your array. Len(), ndim, size, dtype, shape, info() 7b. Apply the aggregate functions on this data and print the results. (Functions like min(), max(), cumsum(), mean(), median(), corrcoeff(), std())	CO-3
LSO 8.1 Handle multiple arrays by applying various operations on arrays	8	<b>Handling Multiple Arrays</b> 8a. Create two python NumPy arrays (boys, girls) each with the age of nstudents in the class. 8b. Get the common items between twopython NumPy arrays. 8c. Get the positions where elements of twoarrays match. 8d. Remove from one array those items thatexist in another. 8e. Extract all numbers between a given rangefrom a NumPy array.	CO-3
LSO 9.1 Apply indexing on the given set of data	9	<b>Indexing in NumPy</b> 9a. Load your class Mark list data from a csv file into an array. 9b. Access the mark of a student in a particular subject using indexing techniques. 9c. Select a subset of 2D array using fancy indexing (indexing using integer arrays	CO-3
LSO 10.1 Create series using list and dictionary in pandas	10	<b>Working with a Series using Pandas</b> 10a. Create a series using list and dictionary.	CO-4

Practical/ Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
LSO 10.2 Print different values from series.		10b. Create a series using NumPy functions in Pandas. 10c. Print the index and values of series. 10d. Print the first and last few rows from the series.	
LSO 11.1 Perform various operation in a Data Frame rows	11	<b>Working with Data Frame Rows</b> 11a. Slicing Data Frame using loc and iloc. 11b. Filter multiple rows using isin. 11c. Select first n rows and last n rows 11d. Select rows randomly n rows and fraction of rows (use df. sample method) 11e. Count the number of rows with each unique value of variables 11f. Select n largest and n smallest values. 11g. Order/sort the rows	CO-4
LSO 12.1 Apply different techniques to merge and combine data	12	<b>Merge and combine data</b> 12a. Perform the append, concat and combine first operations on Data Frames. 12b. Apply different types of merge on data. 12c. Use a query method to filter Data Frame with multiple conditions.	CO-4
LSO 13.1 Create Linear Plot to identify various relation in the data using Matplotlib LSO 13.2 Create Scatter Plot to identify various relation in the data using Matplotlib	13	<b>Consider the Salary dataset, which contains 30 observations consisting of years of working experience and the annual wage. Download the data set from <a href="https://www.kaggle.com/rohankayan/years-of-experience-and-salary-dataset">https://www.kaggle.com/rohankayan/years-of-experience-and-salary-dataset</a></b>  13a. Create a linear plot to identify the relationship between years of working experience and the annual wages with suitable title, legend and labels. 13b. Create a scatter plot to identify the relationship between years of working experience and the annual wages with title, legend and labels. 13c. Also distinguish between observations that have more than 5 years of working experience and observations that have less than 5 years of working experience by using different colors in one single plot.	CO-5
LSO 14.1 Plot Bar graph by Changing the color of each bar, Change the Edge color, Linewidth and Line style.	14	<b>Consider the Iris dataset, where observations belong to either one of three iris flower classes. Download the data set from <a href="https://www.kaggle.com/arshid/iris-flower-dataset">https://www.kaggle.com/arshid/iris-flower-dataset</a></b> 14a. Visualize the average value for each feature of the Setosa iris class using a bar chart. 14b. Format the obtained bar graph by Changing the color of each bar, Change the Edge color, Line width and Line style.	CO-5

- 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: T2400504C**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.1. a. Describe the concept of IoT. TSO.1. b. Explain the functions of each block of the Basic IoT system. TSO.1. c. Compare features of various IoT platforms TSO.1. d. List IoT Real time Applications. TSO.1. e. Describe the functioning of given real-time applications	<b>Unit-1.0 Introduction to IoT</b>  1.1 Basics of IoT, concepts of IoT, History of IoT 1.2 Basic IoT System and its building blocks 1.3 Various platforms for IoT (e.g. AWS, AZURE, GCP) 1.4 Introduction to Python programming and IoT software 1.5 Applications of IoT	CO-1 and CO-5
TSO.2. a. Explain various communication protocols. TSO.2. b. Explain working and application of blue tooth TSO.2. c. Explain working and application of ZigBee TSO.2. d. Explain working and application of LoRa TSO.2. e. Explain working and application of Wi-fi	<b>Unit 2.0 IoT Communication Protocols</b>  2.1 Basics of given communication protocol alongwith its applications 2.2 Explain Communication Protocols MQTT 2.3 Bluetooth Low Energy ZigBee LoRa Wi-fi	CO-1 and CO2
TSO.3. a. Differentiate between sensor and Actuator. TSO.3. b. Classify IoT sensors on the basis of their application. TSO.3. c. Describe the function of each block of Node MCU. TSO.3. d. Explain the procedure to connect sensors with Node MCU.	<b>Unit-3.0 Sensors and Hardware for IoT</b>  3.1 Sensors and Actuators, Transducers, Classifications of sensors, IoT Sensors 3.2 Development Boards, classifications, and basics of wireless networks, WiFi libraries 3.3 Introduction to node MCU, block diagram, functions, interfacing with sensors and publishing data on webserver 3.4 Device integration with node MCU 3.5 Interfacing of sensors with boards	CO-1, CO-3 and CO-5
TSO.4. a. Define APIs and its uses TSO.4. b. Explain working and application of REST. TSO.4. c. Explain working and application of SOAP TSO.4. d. Explain working and application of json TSO.4. e. Explain the integration of API in IoT application development.	<b>Unit.4.0 IoT APIs and its Integration</b>  4.1 Explain APIs and its use 4.2 Explanation of given IoT APIs along with its applications 4.3 MQTT, Broker, subscriber, publisher <b>4.4 REST</b> <b>SOAP</b> <b>4.5 JSON</b> <b>4.6 Programming API using Python</b>	CO-1 and CO-4
TSO.5. a. Differentiate between industrial IoT and IoT.	<b>Unit. 5.0 IoT Applications: -</b>	CO-1 and CO-5

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.5. b. Describe the applications of IoT in the medical field. TSO.5. c. Describe the medical applications of IoT in the agriculture field. TSO.5. d. Describe the innovative IoT applications.	5.1 Industrial IoT and Internet of everything 5.2 IoT for consumer electronics products 5.3 IoT for Medical applications 5.4 IoT for Agriculture 5.5 IoT for security and Law enforcement	

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

### K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400504C

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant CosNumber (s)
LSO 1.1 List various IoT platforms. LSO 1.2 List Down broad features of given platforms. LSO 1.3 List IoT based features in python language.	1.	Prepare a list of platforms used for IoT. Prepare a list of features of above IoT platforms. Prepare a list of features provided by python language for IoT applications.	CO-1
LSO 2.1 Arduino connection with Arduino IDE. LSO 2.1 Connect Bluetooth with Arduino. LSO 2.3 verification of data communication with Bluetooth.	2.	Establish connectivity between various components of IoT. Establish connection between Arduino and Bluetooth module. Establish connection using WiFi	CO-2
LSO 3.1 Measure the temperature of the givensensor. LSO 3.2 Measure the humidity of the given sensor. LSO 3.3 Measure the pressure of the given sensor.	3.	Publish data on the IoT platform. Measure the temperature of a remotely located temperature sensor Using IOT based temperature data-monitoring system. Measure the humidity of a remotely located humidity sensor Using IOT based humidity data-monitoring system. Measure the pressure of a remotely located pressure sensor Using IOT based pressure data-monitoring system.	CO-3
LSO 4.1 Working with APIs. LSO 4.2 Implementation of APIs using POSTMANApplication.	4	Download and Configure POSTMAN Application Verify REST APIs through POSTMAN. Verify JSON APIs through POSTMAN. Verify SOAP APIs through POSTMAN.	CO-4
LSO 5.1 Identification of components for variousapplications. LSO 5.2 Estimate the cost for components.	5.	Identify components for given project Estimate the cost to make Project working.	CO-5

## J) Theory Session Outcomes (TSOs) and Units:T2400504D

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p>TSO 1a. Describe the various historical/evolutionary steps of drone technology</p> <p>TSO 1b. Explain Drone motion based on principle of aerodynamics.</p> <p>TSO 1c. Classify different types of drones and make chart of its application, advantages and disadvantages</p> <p>TSO 1d. Develop attitude to follow proper rules and regulations of drones flying in India.</p> <p>TSO 1e. Explore future prospects of drones in India.</p>	<p><b>Unit-1.0 Introduction to Drone Technology</b></p> <p>Introduction to Drones and UAV</p> <ul style="list-style-type: none"> <li>• Definition</li> <li>• History</li> <li>• Drone in Indian aspect</li> </ul> <p>Introduction to Flight Dynamics</p> <p>Various types of Drones and their respective Applications</p> <ul style="list-style-type: none"> <li>• Multirotor drones</li> <li>• Fixed wing structure</li> </ul> <p>Drone flights using an understanding of FAA</p> <ul style="list-style-type: none"> <li>• DGCA</li> <li>• Digital sky platform</li> <li>• RPTO</li> </ul> <p>Drone regulations-No drone zones</p>	CO-1
<p>TSO 2a. Explain the use and function of different types of Drone components.</p> <p>TSO 2b. Select suitable drone frame and propellers for given application.</p> <p>TSO 2c. Explain working principle and function of different sensors used in drone technology.</p> <p>TSO 2d. Write use of Gyro sensor and Accelerometer in drone.</p> <p>TSO 2e. Describe different types and capacity of Battery used in various drone applications.</p> <p>TSO 2f. State the selection criteria of motor for given drone application.</p> <p>TSO 2g. Write advantage of BLDC motors in making of Drones.</p>	<p><b>Unit-2.0 Drone and its components</b></p> <p>Drones components</p> <ul style="list-style-type: none"> <li>• Drone frame</li> <li>• Propellers</li> </ul> <p>Sensors</p> <ul style="list-style-type: none"> <li>• Gyro sensor and Accelerometer</li> <li>• Speed and Distance Sensor</li> <li>• Temp sensor</li> <li>• Barometer</li> <li>• TOF Sensor</li> </ul> <p>Battery</p> <ul style="list-style-type: none"> <li>• Types and Capacity</li> </ul> <p>Motors</p> <ul style="list-style-type: none"> <li>• Motor types</li> <li>• Motor capabilities</li> <li>• Application of BLDC motors in drones</li> </ul>	CO-2
<p>TSO 3a. Explain four types of motion used in drone's operation.</p> <p>TSO 3b. Describe the working and applications of Electronic speed controller.</p> <p>TSO 3c. Explain the working principle of Flight controller unit used in drone.</p> <p>TSO 3d. Explain Radio communication unit used in drone.</p> <p>TSO 3e. Explain the communication of Flight controller board with motor, ESC and sensors</p>	<p><b>Unit-3.0 Drone controller and motion</b></p> <p>Propulsion and Vertical Motion</p> <p>Controller and Flying Instructions</p> <p>Electronic speed Controller (ESC)</p> <p>Flight Controller Board (FCB)</p> <p>Radio Communication</p> <p>Transmitter and Receiver for radio signal</p>	CO-3

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
with suitable diagram		
<p>TSO 4a. Describe utility of different communication port used in drone.</p> <p>TSO 4b. Identify different types of connectors and write their specifications</p> <p>TSO 4c. Explain the use of drone simulator software and hardware.</p>	<p><b>Unit-4.0 Connections and Interfaces of Devices in Drone and Drone Simulator</b></p> <p>Communication Port</p> <ul style="list-style-type: none"> <li>• PWM</li> <li>• RS232, RS422, RS485</li> <li>• UART</li> <li>• CAN</li> <li>• I2C</li> </ul> <p>Different types of connectors and its specification</p> <p>Drone Simulator software</p> <p>Drone simulator Hardware</p>	CO-4
<p>TSO 5a. Write basic code in Python.</p> <p>TSO 5b. Explain structure and components of a Python program.</p> <p>TSO 5c. write syntax of loops and decision statements in Python.</p> <p>TSO 5d. Explain steps to create functions and pass arguments in Python.</p>	<p><b>Unit-5.0 Introduction to Python for Drone</b></p> <p>Python programming refreshers for IoT, AI and Drone</p> <p>Integration of devices with cloud services</p> <p>Microsoft Azure, AWS</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: P2400504D

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1 Choose suitable materials for making drone frame.	1.	Determine the strength of materials used in drones frame.	CO-2
LSO 2 Select suitable materials for making drone propellers.	2.	Determine the strength of materials used in drones Propellers.	CO-2
LSO 3 Use appropriate battery as per need of flight time for specific drone application.	3.	Test different parameters of batteries used in drones	CO-2
LSO 4 Identify suitable motors as per payload of specific drone application.	4.	Test motors suitable for specific Drone application.	CO-2
LSO 5 Operate Gyro sensor and Accelerometer.	5.	Test and measure Gyro sensor and Accelerometer and their characteristics.	CO-2
LSO 6.1 Identify different sensors based on their characteristics. LSO 6.2 Interface different types of sensor in drone.	6.	Test different sensors and their characteristics with Microcontroller based Flight controller board.	CO-2, CO-3
LSO 7 Demonstrate four type of drone motion.	7.	Determine thrust/torque of motor by changing different drone motion	CO-2, CO-3
LSO 8.1 Configure Flight control board (FCB) LSO 8.2 Demonstrate use of Flight control board (FCB)	8.	Test and troubleshoot Flight control board (FCB).	CO-3
LSO 9.1 Measure various parameters of sensor LSO 9.2 Interface sensor with flight controller board.	9.	Test and perform communication of Flight control board (FCB) with sensor	CO-3, CO-2
LSO 10 Use motor with flight controller board.	10.	Test and perform communication of Flight control board (FCB) with motor.	CO-3, CO-2

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 11 Interface ESC with flight controller board.	11.	Test and perform communication of Flight control board with ESC.	CO-3
LSO 12 Configure radio communication device to control drones	12.	Test and perform communication of Flight control board with RF transceiver.	CO-3
LSO 13.1 Identify different types of ports and connectors of drone. LSO 13.2 Assemble drone component.	13.	Test Hardware assembly for drone.	CO-4 CO-3
LSO 14.1 Identify different motions in drone simulator. LSO 14.2 Operate drone in simulator for specific task	14.	Perform different motion in drone simulator.	CO-4
LSO 15.1 Write code of loop and decision statement in python. LSO 15.2 Interpret loop and decision statement LSO 15.3 Debug code of loop and decision statement	15.	Build and run loops and decision statements for specific application in Python.	CO-5
LSO 16.1 Make function in python. LSO 16.2 Interpret given function statement LSO 16.3 Debug code of function in python	16.	Build and Run functions for specific application and pass arguments in Python.	CO-5
LSO 17.1 Identify python programming steps to interface drone components. LSO 17.2 Identify error in python program LSO 17.3 Debug the given python program	17.	Write basic programming in python to interface different component of Drones	CO-5, CO-3

L) **Suggested Term Work and Self Learning: S2400504D** 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. Design drone for simple application.
2. Test different sensors, their characteristics and make chart which are used in different drones' applications.
3. Download 5 videos on drone design with different components. Watch them and write report on it.
4. Write report on Drone application for precision agriculture.
5. Survey nearby electronics shop and Prepare report of list of drone component and its specification.
6. Visit nearby tool room, small industry, Drone training institute facilities. Prepare report of visit with special comments of drone technology used, material used, cost of printed component.

**c. Other Activities:**

1. Seminar Topics-History of Drone, Drone regulations, Proximity sensor, Bernoulli's principle apply in drone, Radio communication used in drones, Drone Simulator, Python Programming.
2. Visits: Visit nearby tool room, small industry, Drone training institute facilities. Prepare report of visit with special comments of drone technology used, material used, cost of printed component.
3. Surveys: Survey nearby electronics shop and Prepare report of list of drone component and its specification and explore Drone simulator.
4. Product Development
5. Software Development

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: T2400504E**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1a.</i> Explain CAD-CAM and related terminologies.</p> <p><i>TSO 1b.</i> Convert the given CAD file format into others.</p> <p><i>TSO 1c.</i> Transfer the given CAD data to CAM facilities.</p> <p><i>TSO 1d.</i> Classify 3D Printing processes.</p> <p><i>TSO 1e.</i> List the advantages of additive manufacturing processes over conventional manufacturing processes.</p> <p><i>TSO 1f.</i> List typical steps involved in 3D printing of an object from digital model.</p> <p><i>TSO 1g.</i> Explain reverse engineering steps for 3D Printing.</p>	<p><b>Unit-1.0 Additive Manufacturing Introduction and CAD</b></p> <p>1.1 CAD-CAM and its integration.</p> <p>1.2 CAD- Part and Surface modeling.</p> <p>1.3 CAD file formats.</p> <p>1.4 Additive v/s Conventional Manufacturing processes.</p> <p>1.5 Process chain for 3D Printing.</p> <p>1.6 Classification of 3D Printing Processes.</p> <p>1.7 Product design and prototyping.</p> <p>1.8 Reverse Engineering for 3D Printing.</p>	CO1
<p><i>TSO 2a.</i> Explain the given STL interface terminology.</p> <p><i>TSO 2b.</i> Use the given alternative 3D printing interface.</p> <p><i>TSO 2c.</i> Generate STL file for the given CAD file.</p> <p><i>TSO 2d.</i> Repair the given STL file.</p> <p><i>TSO 2e.</i> Apply part orientation and support techniques for the given situation.</p> <p><i>TSO 2f.</i> Perform slicing of the given CAD model using the given slicing software.</p> <p><i>TSO 2g.</i> Generate tool path using simulation software for the given situation.</p>	<p><b>Unit-2.0 Data Preparation for 3D Printing</b></p> <p>2.1 STL interface Specification, STL data generation, STL data Manipulation.</p> <p>2.2 Advantages and limitations of STL file format, Open files, Repair of STL files,</p> <p>2.3 Alternative 3D Printing interfaces.</p> <p>2.4 Part orientation and support generation, Factors affecting part orientation, Various models for part orientation determination.</p> <p>2.5 The function of part supports, Support structure design, Automatic support structure generation.</p> <p>2.6 Model Slicing and Contour Data organization, Direct and adaptive slicing: Identification of peak features, Adaptive layer thickness determination.</p> <p>2.7 Tool path generation.</p>	CO1, CO2
<p><i>TSO 3a.</i> Explain the given 3D Printing process.</p> <p><i>TSO 3b.</i> Select FDM 3D Printing materials for the given application.</p> <p><i>TSO 3c.</i> Select FDM based 3D Printing processes parameters for given application with justification.</p>	<p><b>Unit-3.0 Additive Manufacturing Techniques</b></p> <p>3.1 Fused Deposition Modeling (FDM), Stereo lithography (SLA), Selective Laser Sintering (SLS), Binder Jetting, Material Jetting, Direct Energy Deposition and Laminate Object Manufacturing.</p> <p>3.2 FDM based 3D printing process details.</p> <p>3.3 3D Printing materials and selection for FDM.</p>	CO3, CO4

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	3.4 FDM Process parameter for various applications.	
<p><i>TSO 4a.</i> Identify various Aerospace, Electronics, Health care, Automotive, Construction, Food processing, Machine tool components that can be 3D Printed.</p> <p><i>TSO 4b.</i> Estimate the cost and time of FDM based 3D printing of the given component.</p>	<p><b>Unit-4.0 Application of 3D Printing</b></p> <p>4.1 Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defense, Automotive, Construction, Food Processing, Machine Tools</p>	CO3, CO4
<p><i>TSO 5a.</i> Select suitable 3D Printer (FDM) and software for the given application with justification.</p> <p><i>TSO 5b.</i> Analyze the effect of given FDM based 3D printing process parameters using 3D printer software simulation.</p> <p><i>TSO 5c.</i> List steps to perform 3D scanning of the given object.</p> <p><i>TSO 5d.</i> Repair 3D scanned digital model.</p> <p><i>TSO 5e.</i> Set different FDM 3D printing process parameters to get a sound plastic component.</p>	<p><b>Unit-5.0 3D Printers and Software and Scanners</b></p> <p>5.1 Construction details and working of established FDM based 3D printers for plastics parts.</p> <p>5.2 Accuracy, Precision and Tolerance in 3D printing.</p> <p>5.3 3D Printer software- Fusion 360, Solidworks, Onshape, Tinkercad, Ultimaker Cura, MeshLab, Simplyfy 3D, Repetier host, Slic3r, etc. – use and operation of anyone.</p> <p>5.4 3D Scanners and working.</p> <p>5.5 Producing a part using FDM based 3D Printer.</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: P2400504E

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<p><i>LSO 1.1.</i> Use CAD software.</p> <p><i>LSO 1.2.</i> Prepare digital models of simple 3D entities.</p>	1.	Develop digital models of following simple components using any CAD software: <ul style="list-style-type: none"> <li>• Nut</li> <li>• Bolt</li> <li>• Network cable Jack</li> <li>• Coat button</li> <li>• Spoon</li> </ul>	CO1
<p><i>LSO 2.1.</i> Prepare digital models of complex 3D entities and assemblies.</p>	2.	Develop digital models of following assemblies using any CAD software: <ul style="list-style-type: none"> <li>• Connecting Rod</li> <li>• Piston</li> <li>• Electric switch</li> <li>• Bathroom Tap</li> <li>• Mouse</li> </ul>	CO1
<p><i>LSO 3.1.</i> Surf web for downloading readymade free CAD models.</p> <p><i>LSO 3.2.</i> Convert one CAD file format into another.</p>	3.	Download three digital CAD models freely available on web in different formats and then convert them into .stl/obj format.	CO1
<p><i>LSO 4.1.</i> Use the given Slicing software for 3D Printing.</p> <p><i>LSO 4.2.</i> Perform slicing operation on the given digital model.</p>	4.	Perform slicing operation on one digital model available under each Pr. No.1, 2 and 3.	CO2
<p><i>LSO 5.1.</i> Use the available 3D printing software.</p> <p><i>LSO 5.2.</i> Selection of 3D printing process and performance parameters.</p>	5.	Analyse the effect of different process parameters, materials on printing time, material required, surface finish, etc. through	CO3, CO4, CO5

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
		simulation using 3D printing software on sliced models available from Pr. No. 4	
<p><i>LSO 6.1.</i> Produce single plastic components using available 3D printer.</p> <p><i>LSO 6.2.</i> Perform post processing operations on printed component.</p>	6.	Print one single component on available FDM based 3D printer with PLA/ABS material	CO3, CO4, CO5
<p><i>LSO 7.1.</i> Select appropriate layer thickness, tolerance, fit.</p> <p><i>LSO 7.2.</i> Produce an assembly of plastic components using available 3D printer.</p>	7.	Print one assembly on available FDM based 3D printer with PLA/ABS material	CO3, CO4, CO5
<p><i>LSO 8.1.</i> Choose suitable material for printing flexible structure (assembly of same small pieces to give flexible fabric effect).</p> <p><i>LSO 8.2.</i> Choose suitable design/shape to create a flexible type structure.</p> <p><i>LSO 8.3.</i> Produce flexible plastic structure using available 3D printer.</p>	8.	Model and print a flexible fabric structure with PLA/ABS material (assembly of same small pieces to give flexible fabric effect)	CO3, CO4, CO5
<i>LSO 9.1.</i> Selection of 3D printing process parameters.	9.	Change printing process parameters and repeat experiment number 6.	CO4, CO5
<p><i>LSO 10.1.</i> Use of available 3D scanner.</p> <p><i>LSO 10.2.</i> Develop 3D digital model using scanning approach.</p> <p><i>LSO 10.3.</i> Modeling of complex 3D objects using 3D scanning.</p>	10.	Scan the given complex component using available 3D Scanner.	CO5
<p><i>LSO 11.1.</i> Produce a complex plastic structure using available 3D printer and scanner.</p> <p><i>LSO 11.2.</i> Apply Reverse Engineering approach to exactly 3D print an existing real object.</p>	11.	Print the 3D scanned digital model of Pr. No. 10 on available FDM based 3D printer with PLA/ABS material	CO5

L) **Suggested Term Work and Self Learning: S2400504E** 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. Perform 3D printing of plastic casing of inhaler used by Asthma patients and estimate the cost.
2. Download 5 videos on 3D printing of different components, 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. Print two pieces of same components using ABS and PLA and compare their strength, surface roughness, weight, cost.
4. Download two 3D printing free software and try to check their compatibility with your lab printer.

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, Society connect, Multidisciplinary aspects, Indian Knowledge System (IKS) and others need to be integrated.

J) **Theory Session Outcomes (TSOs) and Units: T2400504F**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p>TSO.1. a Describe Industry 4.0 and its component</p> <p>TSO.1. b Explain different types of automation systems</p> <p>TSO.1.c Identify the type of automation used in a given industry</p> <p>TSO.1.d Analyze the working of industrial processes and products for automation.</p> <p>TSO.1.e Select principles and strategies for automation for a given situation using 4R's and 1U</p> <p>TSO.1. f Select criteria for factory automation and processes automation for a given industry.</p> <p>TSO.1. g Describe briefly different systems used for industrial automation.</p> <p>TSO.1.h Describe IOT, IIOT and role of robots with respect to automation.</p>	<p><b>Unit-1.0 Overview of Industrial Automation</b></p> <p>Introduction to Industry 4.0 and its components, Issues and challenges in automation</p> <p>Need of automation in industries, Principles and strategies of automation, factory automation, process automation</p> <p>Basic elements of an automated system, Structure of Industrial Automation Advanced automation functions, Levels of automations</p> <p>Industrial control Systems- Process and Discrete system</p> <p>Types of automation system: Fixed, Programmable, Flexible IntegratedAutomation and its application</p> <p>Different systems used for Industrial automation: PLC, HMI, SCADA, DCS, Drives.</p> <p>Introduction to Internet of Things (IoT) and Industrial Internet of Things (IIOT) and its application in Automation.</p> <p>Role of robots in automation and its components.</p>	CO1
<p>TSO.2. a Explain PLC and list its advantages over relay systems.</p> <p>TSO.2.b Distinguish between PLC and a PC, PLC and dedicated controllers.</p> <p>TSO.2.c List the types of PLCs and brands available in the market.</p> <p>TSO.2.d Describe the function of each block of a PLC with the help of a block diagram.</p> <p>TSO.2.e Describe the basic sequence of operation of a PLC with a simple example.</p> <p>TSO.2.f Explain different PLC programming languages with simple examples.</p> <p>TSO.2.g Describe a simple PLC programming using ladder logic specifying I/O addressing</p> <p>TSO.2.h List the applications of PLC</p>	<p><b>Unit-2.0 Fundamentals of PLC</b></p> <p>Introduction to PLC, evolution of PLC</p> <ul style="list-style-type: none"> <li>• Comparison of PLC and Personal Computer(PC)</li> <li>• Comparison of PLC and dedicated controllers like PAC and CNC</li> <li>• Types of PLC – Fixed, Modular and their types</li> <li>• Different brands of PLCs available in the market</li> </ul> <p>Building blocks of PLC -CPU, Memory organization, Input-Output modules (Discrete and Analog) Specialty I/O Modules, Power supply</p> <p>PLC programming languages with simple examples:</p> <ul style="list-style-type: none"> <li>• Functional Block Diagram (FBD),</li> <li>• Instruction List.</li> <li>• Structured text,</li> <li>• Sequential Function Chart (SFC),</li> <li>• Ladder Programming</li> </ul> <p>PLC I/O addressing in ladder logic</p> <p>Simple programming example using ladder logic</p> <p>Applications of PLC:</p> <p>Traffic light control, Elevator control, Motor sequencing control, Tank level control, temperature</p>	CO2

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	control, Conveyor system control	
<p>TSO.3.a Identify the commonly used input field devices in PLC installations along with their symbols.</p> <p>TSO.3.b Draw symbol of various switches used in PLC installations describing the function of each switch.</p> <p>TSO.3.c Identify the various digital input devices used in a PLC installation.</p> <p>TSO.3.d Identify the commonly used sensors as input field devices found in PLC installations.</p> <p>TSO.3.e Describe the working of different types of discrete sensors giving their applications.</p> <p>TSO.3.f Describe the working of different types of advanced sensors giving their applications.</p> <p>TSO.3.g Select Sensors as per the given requirement for ecofriendly automation.</p>	<p><b>Unit 3.0 – Sensors and Input field Devices</b></p> <p>Analog input devices-Electromagnetic relays, Contactors, Motor starters, Manually operated Switches Toggle switch, pushbutton switch, knife switch and selector switches Mechanically operated switches, Limit switch, Temperature switch (Thermostat), Pressure switch, Level switch and their symbols Discrete/Digital Input device, Construction and working of Sensors</p> <ul style="list-style-type: none"> <li>• Proximity sensors- Inductive, Capacitive, Optical and ultrasonic</li> </ul> <p>Advanced sensors- Construction and working of</p> <ul style="list-style-type: none"> <li>• Temperature sensors- Thermistor, Thermocouple and Resistance temperature Detector (RTD)</li> <li>• Liquid level sensor -Capacitive and Ultrasonic</li> <li>• Force -Strain/Weight sensors</li> <li>• Flow sensors – turbine flow sensor</li> <li>• Pressure sensors- Linear Variable Differential Transformer (LVDT)</li> <li>• Inclination sensor -Inclinometer</li> <li>• Acceleration sensor- Accelerometer</li> </ul> <p>Angular and linear position sensor</p>	CO3
<p>TSO.4.a Classify the actuators.</p> <p>TSO.4.b Describe the construction and working of a given actuator.</p> <p>TSO.4.c Explain the basic principle of operation of a given actuator.</p> <p>TSO.4.d Differentiate between hydraulic and pneumatic actuators</p> <p>TSO.4.e Explain the basic principle of operation of a given control valve.</p> <p>TSO.4.f Select actuators and valves as per the given requirement for ecofriendly automation.</p> <p>TSO.4.g Develop different hydraulic and pneumatic circuits for simple application.</p> <p>TSO.4.h Identify the commonly used output field devices in PLC installations</p> <p>TSO.4.i Draw the symbol of various output devices used in PLC installations describing the function of each.</p> <p>TSO.4.j Select output devices for a PLC installation as per the requirement.</p>	<p><b>Unit 4.0- Actuators and Output Devices</b></p> <p>Introduction to actuators, Classification of actuators Mechanical actuators -Translational and rotation motion, kinematic chains, cams, gears, belt and chain drives, bearings Hydraulic and Pneumatic actuators- linear and rotary actuators, single and double acting cylinder, directional, process and pressure control valves Electrical actuators</p> <ul style="list-style-type: none"> <li>• Electromechanical actuators Construction, working and application of Stepper motors, AC/DC Servo motors, BLDC Motor (Very brief)</li> <li>• Electrohydraulic actuators-Construction, working and application of Electro- hydrostatic actuator (EHA), ON/OFF Electro-hydraulic Rotary Actuator (E2H90, Control Valve Rotary Actuator (E2HR), Solenoid valve</li> </ul> <p>Thermal actuators -Construction, working and application of Hot-And-Cold-Arm Actuators, Chevron-Type Actuators Magnetic actuators- Construction, working principle and application of Moving coil actuators, moving magnet actuator, Moving iron actuator Selection criteria of actuators</p>	CO4

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	Other Output devices- Indicators, Alarms Pilot Lights, Buzzers, Valves, Motor starters, Horns and alarms, Stack lights Control relays,Pumps and Fans.	
TSO.5.a Describe the basic process control system with the help of a block diagram TSO.5.b Explain the types of control available in a process control TSO.5.c Describe the different types of controllers in a closed loop system with the help of a block diagram TSO.5.d Describe the construction, working and application of a given control system components.	<b>Unit 5.0– Control System</b>  Block diagram of a basic control system Open and closed loop system, their transfer function First order and second order system and their output response and parameters Different types of inputs-step and ramp Types of control – On-off, Feed forward, Open loop and closed loop control and Transfer function Controllers in closed loop control <ul style="list-style-type: none"> <li>● Proportional Controller (P Controller)</li> <li>● Integral Controller (I Controller)</li> <li>● Derivative controller (D- Controller)</li> <li>● P-I Controller</li> <li>● P-D Controller</li> </ul> PID Controller	<b>CO5</b>

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

### K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400504F

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1 Identify various building blocks and major automation components in a given robotic system LSO 1.2 Identify various building blocks and major automation components in a given electrical drives	1.	Identify major automation components in a given system	CO1
LSO 1.3 Analyze and plan the steps to automate the given system.	2.	Analyze given traditional machine in the laboratory for and identify the steps and components required to automate it.	
LSO 1.4. Identify the building blocks of a given typical SCADA system LSO 1.5. Identify the symbol library of SCADA software	3.	Use Scada software for simple application	
LSO 2.1 Identify the various parts and front panel status indicators of the given PLC.	4.	Observe various parts and front panel indicators of a PLC	CO2
LSO 2.2 Identify different input and output devices that can be connected to a given PLC.	5.	Observe different types of switches and their symbols sensors, lamp, alarm, motor, fan used in a PLC	
LSO 2.3 Test the analog input and output lines of the given PLC.	6.	Identify Analog input and output lines of a PLC	
LSO 2.4 Test the digital input and outlines of the given PLC.	7.	Identify digital input and output lines of a PLC	
LSO 2.5 Use PLC to control the devices like Lamp, Alarm, motor using push button switches	8.	Practice using PLC to control various digital and analog output devices	
LSO 3.1. Test the response of digital inductive proximity sense or used to detect different types of	9.	Identify different types of digital inductive proximity sensor and its use	CO3

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
materials			
LSO 3.2. Test the response of digital capacitive proximity sensors used to detect o different materials	10.	Identify different types of digital capacitive proximity sensor and itsuse	
LSO 3.3. Test the response of digital optical proximity sensor used to detect different materials	11.	Identify different types of digital optical proximity sensor and its use	
LSO 3.4. Test the response of digital ultrasonic proximity sensors used to detect different materials	12.	Identify different types of digital ultrasonic proximity sensor and itsuse	
LSO 3.5. Use thermistor to measure temperature of a given material	13.	Identify different types ofthermistor and its use	
LSO 3.6. Use Thermocouple to measure the temperature of a given liquid and plot the output voltage versus temperature	14.	Observe the conversion of temperature to electric parameterconversion of a Thermocouple	
LSO 3.7. Use RTD to control the temperature of an oven	15.	Observe different types of RTDs usedin industries for temperature measurement	
LSO 3.8. Use flow sensors to measure the flow of a given liquid or gas	16.	Observe different types of flow sensors used in industries for flowmeasurement	
LSO 3.9. Use pressure sensors to measure the pressure of a liquid or gas	17.	Observe different types of pressure sensors used in industries for pressure measurement	
LSO 3.10. Use load cell for measurement of mechanical force/weight.	18.	Observe the different types of loadcell used in industries for force/weight measurement	
LSO 4.1 Design and actuate pneumatic circuit for lift control LSO 4.2 Design a pneumatic system that rivets the pockets on jeans LSO 4.3 Design pneumatic circuit to open and close the security gate and control the speed. LSO 4.4 Design a circuit for speed control of hydraulic motor meter out circuit by using 4/3 DC valve. LSO 4.5 Design a circuit for speed control of double acting cylinder meter in by using 4/2 dc solenoid valve. LSO 4.6 Designing a circuit for speed control of double acting cylinder meter out by using 4/3 solenoid valve	19.	Design and actuate pneumatic/ hydraulic circuit for the given situation	CO4
LSO 4.7 Direct acting of hydraulic motor	20.	Operate hydraulic motor	
LSO 4.8 Operate stepper motor and control the motor by changing number of steps, the direction of rotation and speed.	21.	Operate stepper motor	
LSO 4.9 Identify the components of thermal and magnetic actuators available in the laboratory. LSO 4.10 Use thermal and magnetic actuators	22.	Thermal and magnetic actuators	
LSO 5.1 Test the output response of a open loop closed loop and feed forward path	23.	Analyze the given system to studyopen loop, closed loop and feed forward path.	CO5

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 5.2 Build and test the output response of a first order system for a step input using a CRO	24.	Analyze the given first order system and its transfer function and output response	
LSO 5.3 Build and test the response of a second order system for a step input using CRO. Also mark various parameters	25.	Analyze the given second order system and its transfer function and output response	
LSO 5.4 Test the Output response of an on-off and Proportional control-based level control system.	26.	Analyze the given water level control system with on-off, Proportional control.	
LSO 5.5 Test the Output response of a P+I+D based level control system.	27.	Analyze the given water level control system with P+I+D control.	

L) **Suggested Term Work and Self Learning: S2400504F** 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.

- i. State three advantages of using programmed PLC timer over mechanical timing relay.
- ii. Prepare a list of open source PLC software
- iii. Prepare a list of open source SCADA software.
- iv. List the practical applications of PLC systems
- v. List the practical applications of SCADA systems.
- vi. Compare the PLC and PC with regard to:
  - Physical hardware differences
  - Operating environment
  - Method of programming
  - Execution of program
- vii. Prepare classification chart of different types of actuators.
- viii. Differentiate between Nano and micro actuators.

b. **Micro Projects:**

1. Develop a relay-based motor control automation such that the motor reverses its direction when the limit switches are activated.
2. Develop a simulation to connect analog and digital input to the PLC.
3. Develop a simulation to connect analog and digital output to the PLC.
4. Develop a simple automatic water level controller using magnetic float switch.
5. Develop a simple automatic door system using optical sensor and linear actuator.
6. Troubleshoot the faulty equipment/kit available in automation laboratory
7. Select one industry and analyze the process and propose the automation strategies' that can be used for automation.
8. Develop a working model of a given application using given actuators and valves.

## J) Theory Session Outcomes (TSOs) and Units: T2400504G

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
<p>TSO 1a. Identify the types of the vehicle based on the physical features, specification data and information.</p> <p>TSO 1b. State the advantages of EVs over Conventional IC Engine Vehicles.</p> <p>TSO 1c. Identify different components of Electric Vehicle systems</p> <p>TSO 1d. Explain the functions of different components of the EV</p>	<p><b>Unit-1.0 Introduction to Electric Vehicle</b></p> <p>Review of Conventional Vehicle Engine System</p> <p>Electric Vehicle (EV)</p> <ul style="list-style-type: none"> <li>• The necessity of Electric Vehicle</li> <li>• Types of Electric Vehicles <ul style="list-style-type: none"> <li>- Plug-in hybrid</li> <li>- Battery electric vehicle</li> <li>- Hybrid electric vehicle</li> <li>- Fuel Cell Electric Vehicle</li> </ul> </li> <li>• Advantages of Electric Vehicles</li> </ul> <p>Electric Vehicle Components: Motor, Motor Controller, Battery, Battery Management System, and ChargingSystem.</p>	CO1
<p>TSO 2a. Explain the general characteristics of motors used in EV</p> <p>TSO 2b. List different types of motors used in EV</p> <p>TSO 2c. Explain the working principles of motors used in EV applications</p> <p>TSO 2d. Interpret the nameplate ratings of the motors for EV applications.</p> <p>TSO 2e. Explain the motor selection criteria for particular EV applications.</p> <p>TSO 2f. Describe the Mechanical and Electrical Connections of Motors.</p>	<p><b>Unit-2.0 Electric Motors used in EVs</b></p> <p>Electric Motors for EV applications</p> <ul style="list-style-type: none"> <li>• General Characteristics of motors</li> <li>• Types of Motors: DC, Brushless DC, Induction, Permanent Magnet Synchronous Motors, Switched Reluctance Motors</li> </ul> <p>Rating of Motors</p> <p>Selection Criteria</p> <p>Physical Location</p> <p>Connection of Motors: Mechanical Connections and Electrical Connections</p>	CO2
<p>TSO 3a. List the batteries used in EVs for energy storage</p> <p>TSO 3b. State various parameters related to batteries used in EV applications.</p> <p>TSO 3c. Explain the charging and discharging process of the given batteries.</p> <p>TSO 3d. Explain the salient features of Lithium Ion batteries</p> <p>TSO 3e. Explain the Fuel Cell Storage System.</p> <p>TSO 3f. Identify various sensors installed for monitoring Battery condition.</p> <p>TSO 3g. Explain Battery Management System in EV using Block Diagram.</p> <p>TSO 3h. <a href="#">Describe the procedure of battery Disposal and Recycling</a></p>	<p><b>Unit- 3.0 EV Batteries and Energy Storages</b></p> <p>Types of Batteries: Lead Acid, Nickel Based, Lithium Based</p> <p>Battery Parameters</p> <p>Charging (AC) and Discharging (DC) Process</p> <p>Lithium Ion Batteries</p> <p>Fuel Cells, Fuel Cell Storage System</p> <p>Battery Condition Monitoring</p> <p>Battery Management System (BMS)</p> <ul style="list-style-type: none"> <li>• Need of BMS</li> <li>• Block Diagram of BMS</li> </ul> <p><a href="#">Battery Disposal and Recycling</a></p>	CO3
<p>TSO 4a. Identify different types of diodes and transistors.</p> <p>TSO 4b. Describe the testing procedure for the given Diode and Transistor.</p> <p>TSO 4c. Explain the working principles of the given power electronic converter circuit.</p> <p>TSO 4d. Describe the types of Charging Systems</p> <p>TSO 4e. Describe different Components of the Charging System</p>	<p><b>Unit- 4.0 EV Charging Systems</b></p> <p>Power electronics in EV</p> <ul style="list-style-type: none"> <li>• Power electronics components</li> <li>• Rectifiers</li> <li>• DC to DC Converter</li> <li>• DC to AC Converter</li> </ul> <p>Charging System</p> <ul style="list-style-type: none"> <li>• Types of charging Systems</li> </ul>	CO4

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
TSO 4f. Explain the working of the Charging System using a single-line diagram.	<ul style="list-style-type: none"> <li>Components of Charging Systems</li> <li>Single line Diagram of Charging System</li> </ul>	
TSO 5a. Understand the Rules and Regulations set by the Government for selecting and manufacturing various components of an electric vehicle. TSO 5b. Understand the Policies for E-Vehicles. TSO 5c. <b>Appreciate the importance of the reduction of greenhouse gases in the environment.</b>	<b>Unit- 5.0 Regulatory Requirements and Policies for EV Industry</b>  Rules and Regulations set by the Indian government for the designer/manufacturer of EVs. Policies in India Global Policies for E- Vehicles. <b>Carbon Footprint Issues</b>	CO5

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

### K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400504G

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
LSO 1.1 Use the relevant digital meter for the given application. LSO 1.2 Use a measuring instrument for the given application. LSO 1.3 Use safety kits while working in the laboratory.	1.	<ul style="list-style-type: none"> <li>Practice using digital meters such as AC, DC Clamp Meters, Digital Multimeters, Lux Meters, etc.</li> <li>Practice using Screw Driver Kit, Vernier Caliper, Micrometer, Ampere Meter, Voltage Meter, and Techno-meter.</li> <li>Practice using safety kits.</li> </ul>	CO1
LSO 2.1 Identify the motors used in EV applications LSO 2.2 Identify the given motor terminals	2.	<ul style="list-style-type: none"> <li>Identification of motors used in EVs</li> </ul>	CO2
LSO 3.1 Identify the batteries available in the laboratory. LSO 3.2 Measure an open circuit voltage of the given battery. LSO 3.3 Determine the Ampere -Hour Capacity of the given battery with a given load. LSO 3.4 Test the performance of the given battery with different charging rates and at different ambient temperatures LSO 3.5 Demonstrate the effect on the state of health of the battery after several charge/discharge cycles. LSO 3.6 Evaluate the temperature cut-off point for the given BMS.	3.	<ul style="list-style-type: none"> <li>Testing of Batteries used in EVs</li> <li>Battery Management System</li> </ul>	CO3
LSO 4.1 Identify the Electrical & Electronics components available in the laboratory using Digital Multimeters. LSO 4.2 Test the given power electronic components using digital meters LSO 4.3 Identify the given Power Electronic Circuits used in EVs LSO 4.4 Identify the components of the Charging System LSO 4.5 Recognize the types of Charging Systems available in the Laboratory	4.	<ul style="list-style-type: none"> <li>Power electronic circuits</li> <li>Identification of Charging systems</li> </ul>	CO4

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: T2400504H**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
TSO 1a. Explain the basic terms used in robotics TSO 1b. Identify components used in robots. TSO 1c. Explain various types of movements. TSO 1d. Distinguish various robots' configurations and their workspace. TSO 1e. Evaluate the degrees of freedom of the given robot. TSO 1f. Specify the methods of conversion of the given linear motion into rotary motion and vice-versa. TSO 1g. List the criteria for selecting robot for the given simple application with justification.	<b>Unit-1.0 Basics of Robotics Systems</b>  1.1 Definition, need, brief history of robotics 1.2 Basic Robot terminology, configuration and its working 1.3 Robot components overview - Manipulator, End effecters, Drive system, Controller, Sensors 1.4 Basic structure of a Robot and Classification – Cartesian, Cylindrical, Spherical, Horizontal articulated (SCARA), Parallel; Mechanical arm, Degree of freedom, Links and joints, Wrist rotation, Mechanical transmission-pulleys, belts, gears, harmonic drive (gear box) 1.5 Linear and Rotary motion and its devices 1.6 Selection criteria for robots	<b>CO1, CO2</b>
TSO 2a. Explain the working of various types of End effecters used in robots with diagram. TSO 2b. Explain with sketches the function of the given sensing device used in a robot. TSO 2c. Describe working of the given sensor used in robot. TSO 2d. Explain the given robot configuration. TSO 2e. Select relevant robot sensors for a given application with justification. TSO 2f. Describe robot machine vision concepts along with block diagram of robot vision system. TSO 2g. Select vision equipment for a given robotic application.	<b>Unit– 2.0 Robot Components</b>  2.1 End effecters: types, sketches, working and applications 2.2 Sensing and Feedback devices: Optical sensors, Proximity sensors, LVDT, Thermocouple, RTD, Thermistor, Force sensing – strain gauge, Piezoelectric, Acoustic sensing Feedback devices; Potentiometers; Optical encoders; DC tachometers; 2.3 Robot machine vision: Block diagram of robot vision system, Vision equipment-camera, Imaging Components: Point, Line, Planar and Volume Sensors, Image processing, Part recognition and range detection	<b>CO3</b>
TSO 3a. Explain with sketches the function of the specified actuator used in a robot. TSO 3b. Differentiate between open loop and closed loop systems. TSO 3c. Explain various robotic controls. TSO 3d. Describe block diagrams of the given control system. TSO 3e. Specify drive system used for robotic control as per requirement. TSO 3f. Differentiate the various robot path	<b>Unit– 3.0 Robotic Drive System and Controller</b>  3.1 Actuators; Hydraulic, Pneumatic and Electrical drives; linear actuator; Rotary drives 3.2 Control systems: Open loop and close loop with applications and its elements, Servo and non-servo control systems – Types, basic principles and block diagram Robot controller; Level of Controller	<b>CO4</b>

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
controls. TSO 3g. Justify the selection of actuators, drives, control system, AC servo motor and path control for making of a robot.	3.3 AC servo motor; DC servo motors and Stepper motors; 3.4 Robot path control: Point to point, Continuous path control and Sensor based path control	
TSO 4a. Explain various robot programming languages. TSO 4b. Programme robot for a given simple job. TSO 4c. Describe the procedure to simulate the given robot movements using the relevant software.	<b>Unit– 4.0 Introduction to Robot Programming</b>  4.1 Need and functions of programming 4.2 Methods of robot programming: Manual Teaching, Teach Pendant, Lead through, Programming languages. Programming with graphics. 4.3 Programming languages: Types, features and applications 4.4 Controller programming 4.5 Simulation for robot movement	<b>CO5</b>
TSO 5a. Select a robot for the given application. TSO 5b. Describe various applications of Robotics. TSO 5c. Explain safety norms in robot handling. TSO 5d. Describe maintenance procedure for the given robot. TSO 5e. Describe common problems in robot operations and suggest remedial action.	<b>Unit– 5.0 Robotics Applications and Maintenance aspects</b>  5.1 Application robots including special types 5.2 Robot maintenance: Need and types 5.3 Common troubles and remedies in robot operation. 5.4 General safety norms, aspects and precautions in robot handling	<b>CO1, CO2, CO3, CO4</b>

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

### K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400504H

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
LSO 1.1 Identify parts of Robot on the basis of function. LSO 1.2 Identify joint type & link parameters (link length, link twist, and Link offset), rotational vs. linear motion, used in robot.	1.	Identify components and different configurations of robots.	CO1
LSO 2.1 Identify different types of robot end effecters. LSO 2.2 Use Mechanical grippers to hold objects. LSO 2.3 Use Vacuum grippers to hold objects.	2.	Pick/hold different objects (shape/weight/stiffness) using robot end effecters.	CO1, CO2
LSOs 3.1 Assemble the complete robot using the components as per the procedure LSO 3.2 Apply the functionalities available in rotor trainer kit. LSO 3.3 Test for various configurations. LSO 3.4 Test for various degrees of freedom.	3.	Assemble robot to test various configurations and degrees of freedom using robot trainer kit.	CO1, CO2
LSO 4.1 Identify various types of sensors used in robotic application. LSO 4.2 Measure angular motion using Synchros. LSO 4.3 Detect objects using optical sensors.	4.	Use different types of robotic sensors for a specific situation.	CO3

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
LSO 5.1 Interface stepper motor. LSO 5.2 Control robot with stepper motor interfacing.	5.	Perform robot control with stepper motor interfacing	CO3
LSO 6.1 Draw the labelled sketch of individual parts and robot arm. LSO 6.2 Assemble the arm using the parts as per the procedure. LSO 6.3 Interface the motor drive and operate.	6.	Assemble robot arms using mechanical transmission components and interface motor drive.	CO2, CO3
LSO 7.1 Use open source or available relevant software to develop pick and place programme. LSO 7.2 Perform simulation.	7.	Perform pick and place operation using Simulation Control Software.	CO5
LSO 8.1 Develop programme for using a robot arm with three degrees of freedom. LSO 8.2 Execute the programme.	8.	Perform 2D simulation of a 3 DOF robot arm.	CO2, CO4, CO5
LSO 9.1 Apply stepper motor control with direction control and step control logic simulation. LSO 9.2 Perform basic PLC programming LSO 9.3 Develop ladder logic programs LSO 9.4 Use programming timers	9.	Programme 5-axis Robotic arm to control various motions.	CO3, CO4, CO5
LSO 10.1 Develop a program for a simple application. LSO 10.2 Execute the robot programme.	10.	Program to execute a simple robot application (like painting, straight welding) using a given configuration.	CO4, CO5

L) **Suggested Term Work and Self Learning: S2400504H** 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 stair climb robot using robotic components.
2. Develop RF controller robot using robotic components.
3. Develop robot for metal detection application using robotic components.
4. Develop line follower robot using robotic components.
5. Develop solar floor cleaner robot using robotic components.
6. Develop solar tracker system using robotic components.
7. Develop a greenhouse managing robot for a horticulture application.

c. **Other Activities:**

1. Seminar Topics: Recent developments in the field of robotics
2. Visits: Visit an automation industry and prepare report for various types of robots employed there and details of any one type of special purpose robot used
3. Case Study: Identify a robotic application in automobiles and present a case study
4. Self-Learning Topics:
  - History of industrial robot
  - Sociological consequences of Robots

**J) Theory Session Outcomes (TSOs) and Units: T2400504I**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1a.</i> Explain the use of transformers in power systems.</p> <p><i>TSO 1b.</i> List the various types of transformers.</p> <p><i>TSO 1c.</i> Explain the exact and approximate equivalent circuits of a transformer.</p> <p><i>TSO 1d.</i> Explain the relations between input and output quantities through phasor diagrams.</p> <p><i>TSO 1e.</i> List the necessity of open and short circuit tests and explain how they should be performed.</p> <p><i>TSO 1f.</i> Explain the concept of voltage regulation and efficiency and list the ways to improve them in transformers.</p>	<p><b>Unit-1.0 Transformer Fundamentals</b></p> <p>1.1 Use of Transformers.</p> <p>1.2 Types of Transformers.</p> <p>1.3 The equivalent circuit of a transformer.</p> <p>1.4 Phasor Diagrams</p> <p>1.5 Open circuit and short circuit tests.</p> <p>1.6 Voltage regulation and efficiency.</p>	CO1
<p><i>TSO 2a.</i> Explain the different constructional parts of a transformer.</p> <p><i>TSO 2b.</i> List the different types of core and its construction and sections.</p> <p><i>TSO 2c.</i> Explain the different types of windings and the necessity of insulation.</p> <p><i>TSO 2d.</i> Explain the different types of cooling.</p> <p><i>TSO 2e.</i> List the different tank structure.</p> <p><i>TSO 2f.</i> Explain the necessity of transformer oil.</p>	<p><b>Unit-2.0 Transformer Construction</b></p> <p>2.1 Constructional Parts.</p> <p>2.2 Core Construction and Core Sections.</p> <p>2.3 Windings and Insulation.</p> <p>2.4 Cooling: Natural Cooling, Forced Oil cooling and Internal Cooling.</p> <p>2.5 Tanks.</p> <p>2.6 Transformer oil.</p>	CO1, CO2
<p><i>TSO 3a.</i> Explain the different connections and vector groups.</p> <p><i>TSO 3b.</i> Explain the three phase to two phase and three phase to single phase connection.</p> <p><i>TSO 3c.</i> List the different types of tap changing positions.</p> <p><i>TSO 3d.</i> Explain the open delta configuration.</p>	<p><b>Unit-3.0 Transformer Operation</b></p> <p>3.1 Connection for transformers: star/star, star/delta, delta/star. Zig-zag/star.</p> <p>3.2 Three phase to two phase connections: Scott connection.</p> <p>3.3 Three phase to one phase connection.</p> <p>3.4 Tap changing: On-load and off-load tap changing positions.</p> <p>3.5 Three phase banks of single phase transformers: Open delta configuration.</p>	CO3, CO4
<p><i>TSO 4a.</i> List the classification of transformer protection.</p> <p><i>TSO 4b.</i> Explain the Buchholz relay and its use in transformers.</p> <p><i>TSO 4c.</i> Explain the different types of transformer protection and the use of indicators in transformers.</p>	<p><b>Unit-4.0 Transformer Protection</b></p> <p>4.1 Classification of transformer protection.</p> <p>4.2 Buchholz Relay</p> <p>4.3 Differential protection</p> <p>4.4 Over current, Over voltage and surge protection.</p> <p>4.5 Temperature indicators, oil level indicators, oil preservation systems, silica gel breather, gas sealed conservators.</p>	CO3, CO4
<p><i>TSO 5a.</i> Explain the objectives of testing of transformers.</p> <p><i>TSO 5b.</i> List the different types of tests.</p> <p><i>TSO 5c.</i> Explain different transformer tests including the Sumpner's test.</p> <p><i>TSO 5d.</i> Explain the insulation and impulse tests.</p>	<p><b>Unit-5.0 Transformer Testing</b></p> <p>5.1 Objectives of transformer testing.</p> <p>5.2 Polarity Test, DC Resistance and voltage ratio tests.</p> <p>5.3 Magnetizing current and core loss tests.</p> <p>5.4 Temperature rise test, back to back connection.</p> <p>5.5 Insulation and Impulse Tests.</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: P2400504I**

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<p><i>LSO 1.1.</i> Knowledge of performing these tests on LV and HV sides.</p> <p><i>LSO 1.2.</i> Determine the equivalent circuit parameters of a transformer.</p>	1.	Conduct open circuit and short circuit tests on a transformer	CO1
<p><i>LSO 2.1.</i> Explain the concept of regulation and efficiency at different loads.</p>	2.	Perform load tests on a transformer.	CO1
<p><i>LSO 3.1.</i> Perform Heat run test on a transformer without being subjected to physical load.</p> <p><i>LSO 3.2.</i> Explain the concept of applying rated voltage and rated current through phantom loading.</p>	3.	Perform the Sumpner's test on two identical transformers.	CO1
<p><i>LSO 4.1.</i> Understand various three phase transformer connections and vector groups.</p>	4.	Perform various connections on three phase transformers and understand vector groups.	CO2
<p><i>LSO 5.1.</i> Explain the Scott connection.</p> <p><i>LSO 5.2.</i> Understand the necessity of conversion.</p>	5.	Three phase to Two phase connection	CO3, CO4, CO5
<p><i>LSO 6.1.</i> Understand the necessity of conversion.</p>	6.	Three phase to single phase connection.	CO3, CO4, CO5
<p><i>LSO 7.1.</i> Explain the concept of open delta configuration in case of any single phase transformer failure.</p>	7.	Perform open delta connection from banks of single phase transformers.	CO3, CO4, CO5
<p><i>LSO 8.1.</i> Explain the concept of CT connections in differential protection.</p> <p><i>LSO 8.2.</i> Understand the working principle of Buchholz Relay.</p>	8.	Understand the differential protection with different CT connections and the working of Buchholz relay.	CO3, CO4, CO5
<p><i>LSO 9.1.</i> Explain the concept of dot convention.</p>	9.	Perform a polarity test on a transformer.	CO4, CO5
<p><i>LSO 10.1.</i> Understand the transformer's failures.</p>	10.	Perform the impulse test on a transformer.	CO5

- 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: T2400504J**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
<p><i>TSO 1a.</i> Explain the need for Optical fiber and 5G Technologies.</p> <p><i>TSO 1b.</i> Define numerical aperture.</p> <p><i>TSO 1c.</i> Classify optical fiber modes with proper sketch.</p> <p><i>TSO 1d.</i> Explain with examples modes of wave propagation through an optical fiber.</p> <p><i>TSO 1e.</i> Classify optical fiber</p>	<p><b>Unit-1.0 Introduction of Optical Fibers</b></p> <p>1.1 Introduction to general optical fibercommunication (OFC) system</p> <p>1.2 Basic optical laws and definitions</p> <p>1.3 Structure of optical cable- core, cladding, cover</p> <p>1.4 Numerical aperture</p> <p>1.5 Optical fiber modes and configurations–mode analysis for optical propagation through fibers</p> <p>1.6 Classification of optical fiber, single mode fiber, graded index fiber</p>	<b>CO1</b>
<p><i>TSO 2a.</i> Explain the reason for attenuation in the optical fiber cable.</p> <p><i>TSO 2b.</i> Describe fiber losses with examples.</p> <p><i>TSO 2c.</i> Explain various aspects of dispersion</p> <p><i>TSO 2d.</i> Describe how to optimize the dispersion</p> <p><i>TSO 2e.</i> Describe how to generate R-I profile</p> <p><i>TSO 2f.</i> calculate cut-off wavelength, and modefield diameter</p>	<p><b>Unit-2.0 Transmission Characteristics of OpticalFiber</b></p> <p>2.1 Attenuation in Optical Fiber</p> <p>2.2 Fiber Losses (Material, Scattering, Splice, Absorption, Radiative)</p> <p>2.3 Dispersion (Chromatic, Modal, Material, Waveguide, Polarization mode)</p> <p>2.4 Dispersion optimization of single mode fiber, characteristics of single mode fiber</p> <p>2.5 R-I Profile</p> <p>2.6 Cut off wavelength, dispersion calculation, and mode field diameter</p>	<b>CO2</b>
<p><i>TSO 3a.</i> Explain the need for a source and detector in an optical fiber system.</p>	<p><b>Unit-3.0 Optical Sources and Detectors</b></p> <p>3.1 Sources- Intrinsic and extrinsic material, direct and indirect band</p>	<b>CO3</b>

<p><i>TSO 3b.</i> Describe about direct and indirect bandgap materials used for make fiber sources.</p> <p><i>TSO 3c.</i> Describe the basic operating principle of optical sources such as LED and Lasers in detail.</p> <p><i>TSO 3d.</i> Describe the detection process and noise in the optical detectors.</p>	<p>gaps</p> <p>3.2 LED structures- Surface-emitting and Edge emitting LED</p> <p>3.3 Optical Source: Laser diodes, Laser source driver circuit, modes and threshold conditions, Rate equations, external quantum efficiency, resonant frequencies, single-mode laser, external modulation, temperature effect</p> <p>3.4 Detectors: PIN photodetector, Avalanche photodiodes, Photodetector noise, noise sources, SNR, detector response time, Avalanche multiplication noise, and temperature effects</p>	
<p><i>TSO 4a.</i> Describe the basic operations of the given type of optical preamplifier.</p> <p><i>TSO 4b.</i> Analyze the performance of the given optical receiver in detail.</p> <p><i>TSO 4c.</i> Describe the power launching and lensing with respect to the optical fiber system.</p> <p><i>TSO 4d.</i> Describe the fiber splicing process with the help of a suitable sketch. Describe the procedure of optical power measurement.</p>	<p><b>Unit-4.0 Optical Receiver, Coupling and Measurements</b></p> <p>4.1 Basic receiver operation, preamplifiers, digital signal transmission, error sources, Front-end amplifiers, probability of error, and receiver sensitivity.</p> <p>4.2 Power Launching, Lensing Schemes for Coupling Management, coupling losses,</p> <p>4.3 Fiber Splicing, and Optical power measurement</p>	<b>CO4</b>
<p><i>TSO 5a.</i> Explain the historical development and technological advancements of wireless communication.</p> <p><i>TSO 5b.</i> Compare different wireless communication systems on the basis of technology, data rate, spectrum, QoS, advantages, and services.</p> <p><i>TSO 5c.</i> Describe WLAN principle, standards, and their practical applications.</p> <p><i>TSO 5d.</i> Describe the concept, architecture, and applications of WLL systems, and their role in telecommunications.</p>	<p><b>Unit-5.0 Fundamentals of 5G Communication</b></p> <p>5.1 Evolution of mobile radio systems</p> <p>5.2 Types of Wireless Communication Systems</p> <p>5.3 Overview of modern mobile communication system (2G, 3G, 4G, 5G)</p> <p>5.4 Wireless Local Area Network</p> <p>5.5 Wireless Local Loop</p> <p>5.6 Service Requirement: Data Rate, Number of users, mobility, energy consumption, spectrum, service quality</p>	<b>CO5</b>

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

**K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400504J**

Practical/Lab Session Outcomes (LSOs)	Sl. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
<i>LSO 1.1.</i> Identify the fiber cable, optical source, detector and other components of the given optical fiber system.	1.	Identification of various components of Optical fiber communication system	<b>CO1</b>
<i>LSO 2.1.</i> Measure the numerical aperture of the given optical fiber cable.	2.	Measurement of Numerical aperture	<b>CO1</b>
<i>LSO 3.1.</i> Measure the attenuation and signal loss in optical fiber using optical time-domain reflectometry (OTDR). <i>LSO 3.2.</i> Measure the signal loss in optical fibers using optical time-domain reflectometry (OTDR).	3.	Attenuation and Signal Loss Measurement	<b>CO2</b>
<i>LSO 4.1</i> Perform tests on fiber optic cables to identify faults using tools like visual fault locators and OTDR. <i>LSO 4.2</i> Troubleshoot faults using tools like visual fault locators and OTDR.	4.	Fiber Optic Cable Testing and Troubleshooting	<b>CO2, CO3</b>
<i>LSO 5.1</i> Test the performance of the given optical source.	5	Performance of optical source (LED, LASER)	<b>CO3</b>
<i>LSO 6.1.</i> Test the performance of the given optical detector.	6	Performance of optical doctor (Photo diode, PIN diode)	<b>CO3</b>
<i>LSO 7.1.</i> Learn techniques for splicing optical fibers. <i>LSO 7.2.</i> Install connectors, crucial for network deployment and maintenance.	7	Optical Fiber Splicing and Monitorization	<b>CO4</b>
<i>LSO 8.1.</i> Conduct BER test. <i>LSO 8.2.</i> Evaluate the performance of optical communication links. <i>LSO 8.3.</i> Evaluate the reliability of optical communication links.	8	Analyze the optical communication system.	<b>CO4</b>
<i>LSO 9.1.</i> Noise Modelling and its effect on Wireless Data Transmission	9.	Characterization and Impact of Noise on Wireless Data Transmission: A Comprehensive	<b>CO5</b>
<i>LSO 10.1</i> Effect of fading on wireless data transmission in terms of outage probability	10.	Evaluating Fading Effects on Wireless Data Transmission: Outage Probability Analysis	<b>CO5</b>

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: (Not Applicable)**

K) **Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400505**

Practical/Lab Session Outcomes (LSOs)		S. No.	Laboratory Experiment / Practical Titles	Relevant Cos Number(s)
LSO1.1	Identify the skills of a Successful Entrepreneur.	1.	Profile summary (about 500 words) of a successful entrepreneur indicating milestone achievements.	CO1
LSO1.2	Determine the charms of entrepreneurship and start-ups	2.	Discussion session with your institute's pass-out students who are successful entrepreneurs.	CO1
LSO1.3	Perform strength, weakness, opportunity, and threat analysis.	3.	SWOT analysis to arrive at your business idea of a product/service.	CO1
LSO1.4	Develop sales & marketing skills	4.	Sale of products to different customers	CO1
LSO2.1	Use creativity and put up a stall in a funfair and write a report of profit/loss.	5.	Creativity and Innovation in Business	CO2
LSO2.2	Innovate a point of sale for a product.	6.	Exhibition cum sale of products prepared out of waste.	CO2
LSO2.3	Generate different business opportunities.	7.	Business ideas (product/service) for intrapreneurial and entrepreneurial opportunities through brainstorming.	CO2
LSO1.5	Discover entrepreneurial potential.	8.	Self-assessment test to discover entrepreneurial traits.	CO1
LSO2.4	Classify domain-specific industries on business parameters.	9.	Survey industries (your stream), and grade them according to the level of scale of production, investment, turnover, and pollution to prepare a report on it.	CO2
LSO3.1	Identify entrepreneurship support institutions beneficial for the enterprise.	10.	Compile the information from the government agencies that will help you set up your business enterprise.	CO3
LSO3.2	Select a suitable funding scheme for the enterprise.	11.	Visit a bank / financial institution to enquire about various funding schemes for small-scale enterprises.	CO3
LSO3.3	Analyze the assessment procedure of bank loans.	12.	Collect loan application forms of nationalized banks / other financial institutions.	CO3
LSO3.4	Compute the financial needs of the business enterprise	13.	Compile the information from financial agencies that will help you set up your business enterprise.	CO3
LSO2.5	Select a business opportunity.	14.	Identify the business opportunity suitable for you.	CO2

Practical/Lab Session Outcomes (LSOs)		S. No.	Laboratory Experiment / Practical Titles	Relevant Cos Number(s)
LSO3.5	Carry-out market survey for a product.	15.	Market Survey for an Enterprise	CO3
LSO4.1	Find out rates of industrial lands and buildings in different industrial areas.	16.	Industrial land and building for Entrepreneurship.	CO4
LSO4.2	Craft a vision statement and enabling mission statements for your chosen enterprise.	17.	Vision statement and mission statement for a Startup.	CO4
LSO4.3	Select a suitable name and brand for the business enterprise.	18.	Branding for a product and a Company.	CO4
LSO4.4	Design a logo, letterhead, and visiting card for the business.	19.	Marketing communication for business.	CO4
LSO4.5	Prepare a techno-feasibility report	20.	A techno-feasibility report of a chosen product/service.	CO4
LSO4.6	Prepare a business plan for the enterprise.	21.	Business plan for the enterprise.	CO4
LSO4.7	Develop a website for the business	22.	Online Marketing for Business.	CO4
LSO3.6	Prepare a set of short-term, medium, and long-term goals for starting a chosen small-scale enterprise.	23.	Goal setting for an enterprise.	CO3
LSO3.7	Prepare an advertising campaign for your chosen product/service.	24.	Marketing management for an enterprise.	CO3
LSO3.8	Establish a supply chain network for the enterprise.	25.	Supply Chain Management	CO3
LSO3.9	Establish a Market intelligence mechanism.	26.	Market Intelligence for Entrepreneurship	CO3
LSO4.8	Compile information about various insurance schemes covering different risk factors.	27.	Risks in business	CO4
LSO4.9	Calculate the breakeven point for the business idea chosen by you.	28.	Breakeven point for a business	CO4