STATE BOARD OF TECHNICAL EDUCATION, BIHAR
Scheme of Teaching and Examinations for
Vth SEMESTER DIPLOMA IN ELECTRONICS (ROBOTICS) ENGG.
(Effective from Session 2023-24 Batch)

THEORY

Sr. No.	SUBJECT	SUBJECT CODE	TEACHING SCHEME Periods per Week	EXAMINATION-SCHEME Hours of Exam	Teacher's Assessment (TA) Marks	Class Test (CT) Marks B	End Semester Exam. (ESE) Marks C	Total Marks (A+B+C)	Pass Marks ESE	Pass Marks in the Subject	Credits
1.	Industrial Instrumentation & Automation	2043501	04	03	10	20	70	100	28	40	04
2.	Microcontroller & PIC	2043502	03	03	10	20	70	100	28	40	03
3.	Auto Electronics	2043503	03	03	10	20	70	100	28	40	03
4.	CAD/CAM	2043504	03	03	10	20	70	100	28	40	03
5.	Elective / COE		02	03	10	20	70	100	28	40	02
	Embedded Processors (2043505A)	Artificial Intelligence (Basics) (2000505B)		Internet of Things (Basics) (2000505C)			Drone Technology (Basics) (2000505D)				
	3D Printing (Basics) (2000505E)	Industrial Automation (Basics) (2000505F)		Electric Vehicles (Basics) (2000505G)			Robotics (Basics) (2000505H)				
			Total: - 15				350	500			15

PRACTICAL

Sr. No.	SUBJECTS	SUBJECT CODE	TEACHING SCHEME Periods per Week	EXAMINATION-SCHEME Hours of Exam.	Internal PA	External ESE	Total Marks (PA+ESE)	Pass Marks in the Subject	Credits
6.	Microcontroller Lab	2043506	06	04	15	35	50	20	03
7.	Elective Lab / COE Lab		04	03	20	30	50	20	02
	Programming in C Lab (2043508A)			Artificial Intelligence (Basics) **Lab** (2000508 B)					
	Internet of Things (Basics) **Lab** (2000508 C)	Drone Technology (Basics) **Lab** (2000508D)		3D Printing (Basics) **Lab** (2000508E)					
	Industrial Automation (Basics) **Lab** (2000508F)	Electric Vehicles (Basics) **Lab** (2000508G)		Robotics (Basics) **Lab** (2000508H)					
			Total: - 10				100		05

TERM WORK

Sr. No.	SUBJECTS	SUBJECT CODE	TEACHING SCHEME Periods per week	EXAMINATION – SCHEME Marks of Internal Examiner (PA)	Marks of External Examiner (ESE)	Total Marks (PA+ESE)	Pass Marks in the Subject	Credits
8.	In plant training (after the end of 4th Semester)	2043509	4 Weeks continuous	30	70	100	40	03
9	Term Work		02	20	30	50	20	01
	NPTEL/MOOCS /Others (2043511)	Artificial Intelligence (Basics) (TW) (2000511 B)	Internet of Things (Basics) (TW) (2000511 C)			Drone Technology (Basics) (TW) (2000511D)		
	3D Printing (Basics) (TW) (2000511E)	Industrial Automation (Basics) (TW) (2000511F)	Electric Vehicles (Basics) (TW) (2000511G)			Robotics (Basics) (TW) (2000511H)		
			Total: - 02			150		04
	Total Periods per week Each of duration one Hour = 27					Total Marks = 750		24

INDUSTRIAL INSTRUMENTATION & AUTOMATION

	Theory			No of Period in one session: 48			Credits
Subject Code 2043501	No. of Periods Per Week			Full Marks	:	100	03
	L	**T**	**P/S**	ESE	:	70	
	04	—	—	TA	:	10	
				CT	:	20	

COURSE LEARNING OBJECTIVE:

Sound Knowledge about transducers, Various Transducer types, measurement methodologies are most important for an Electronic & instrumentation Engineers. Familiarization of PLC, Knowledge about Developing ladder diagrams, usage of timer & counter is necessary in the field of automation.

OBJECTIVES:

1. Understand the Various types of transducer
2. Understand the various types of strain Measurement.
3. Understand the various types of force measurement.
4. Understand the various pressure measuring devices.
5. Understand the Various Flow measuring devices.
6. Understand Basic concepts of PLC.
7. Draw ladder diagram
8. Applications of PLC

UNIT	CONTENTS: THEORY	HOURS
I	**STRAIN AND FORCE MEASUREMENTS** Strain transducers-Strain measuring techniques- resistance strain gauge-Strain gauge materials – metal resistance strain gauges – bonded and unbounded type – wire type strain gauges – metal foil gauges – semiconductor strain gauge. **FORCE MEASUREMENTS**: Force – work – torque – scales & balances – equal arm beam balance – pendulum scale – proving ring – hydraulic load cell – pneumatic load cell – strain gauge load cell.	8
II	**TORQUE AND PRESSURE MEASUREMENTS** Torsion meter – mechanical, optical & electrical types strain gauge torsion meter –dynamometer – mechanical, hydraulic & electric motor generator dynamometers. Terminology – atmospheric – absolute - gauge-static- total pressures-Manometers-U tube manometer-Single column manometers- ring balance-burden gauge-bellow gauge-low pressure gauge - pirani vacuum gauge	10

III	**TEMPERATURE AND FLOW MEASUREMENTS** **TEMPERATURE MEASUREMENT** Temperature scales-temperature measuring instruments-liquid in glass thermometer-Bi-metallic thermometers-filled system- thermocouples-resistance thermometers- thermistors-total radiation Pyrometer **FLOW MEASUREMENTS** Venturi flow meter-pitot tube current meter- turbine meter-rotor meter	**10**	
IV	**BASIC CONCEPTS OF PLC** Introduction to Programmable Logic controller – Hardwired circuits versus PLC control – Advantages of PLC control – Relays – Parts pf PLC – Processor – Memory – Input and output modules – Digital and Analog I/O's – Communication with PLC – Logic functions (OR, AND, NAND & EX –OR)- Remote I/O – The operator interface – Message display – operator input and display –Printed reports – Traffic Displays – Time and Date – Computer boards – Talking to other PLC and computers	**8**	
V	**PROGRAMMING AND APPLICATIONS OF PLC** Ladder Programming Bit instruction – timer- counter – program control instruction – data handling instruction – math instruction – simple ladder diagrams for star- delta starter – Ladder diagrams for DOL starter – Cylinder sequence Application – Cylinder sequence using counter – Ladder diagram using Latch circuit – Ladder diagram using Timer – Ladder diagram using counter – sequence of the operation and ladder diagram for multicylinder application – sequence of the operation and ladder diagram for clean room air lock.	**12**	
		Total-	**48**

Text Books:

1. D.Patranabis, "Principles of industrial instrumentation", tatamcgraw hill, ii edition
2. Electrical & Electronics – measurements & Instrumentation – Sawheney,   Dhanpatrai& sons

Reference Books:

1. Modern Electronic Instrumentation & Measurements Techniques – Albert D. Helfrick and William David Cooper – PHI
2. R.K.Jain, "Mechanical and Industrial Measurements", Khanna Publishers, 11th Edition
3. Instrumentation – Devices & Systems – C.S.Rangan, G.R.Sarma, VSV.Mani, G.K.Mithal, TMH

MICROCONTROLLER & PIC

Subject Code 2043502	Theory			No of Period in one session: 42			Credits
	No. of Periods Per Week			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	03	—	—	TA	:	10	
				CT	:	20	

COURSE LEARNING OBJECTIVE:

Familiarization of Architecture & Functionality of 8051 makes them to work as a complete Engineer. Usage of interfacing helps them to do programming & take-up project works.

OBJECTIVES:

1. Explain Architecture of 8051 Microcontroller.

2. Explain the functions of various registers.

3. Understand interrupt structure of 8051.

4. Understand serial data communication concepts.

5. Understand the programming techniques.

6. Explain various addressing modes.

7. Write simple programs using 8051.

8. Understand the block diagram and control word formats for peripheral devices.

9. Understand how to interface with RS232C.

10. Understand how to interface with 8255.

11. Understand various application of 8051 Microcontroller Understand PIC Microcontroller .

UNIT	CONTENTS: THEORY	HOURS
I	**Architecture of 8051** Block diagram of Microcontroller – Comparison with Microprocessor and Microcontroller – Pin details of 8051 – ALU – Special function registers – ROM – RAM – RAM Memory Map (including registers and register banks) – Program Counter – PSW register –Stack - I/O Ports – Timer – Interrupt – Serial Port – External memory – Clock – Reset – Clock Cycle – Machine Cycle – Instruction cycle – Instruction fetching and execution – Overview of 8051 family	7

II	**Instruction Set and Programming** Assembling and running an 8051 program – Instruction set of 8051 – Data transfer instructions – Different addressing modes – Arithmetic Instructions – Signed number concepts and arithmetic operations – Logic and Compare instructions – Rotate instruction and data serialization – BCD, ASCII – Loop and jump instructions – Call instructions – Time delay routines – Program control – Assembler directives – Sample programs.		**7**
III	**I/O, Timer, Interrupt and Serial Programming** Bit addresses for I/O and RAM – I/O programming – I/O bit manipulation programming – Programming 8051 Timers – Counter programming – Basics of Serial programming – 8051 connection to RS 232 – 8051 Serial Port Programming – 8051 interrupt – Programming Timer Interrupt – Programming external hardware interrupts – Programming the serial communication interrupt – Interrupt priority in 8051		**8**
IV	**Interfacing External Device With 8051** 8051 interfacing to external memory – 8051 interfacing with the 8255 – (Programs are to be written in AssemblY for the following interfacing applications) Relays and opto isolators – Sensors interfacing and signal conditioning – Parallel ADC and Serial ADC interfacing – DAC interfacing - Keyboard interfacing – Seven segment and LCD display interfacing – Stepper Motor interfacing – DC motor interfacing and PWM - RTC Interfacing-Interfacing with I^2C Bus and SPI Bus		**10**
V	**PIC** Over view of PIC 18 family-PIC 18 Features-PIC Architecture -WREG Register in the PIC-PIC File Register File register and access bank in PIC 18- PIC Status Register- Program counter in the PIC-ROM memory map in the PIC18Where the PIC wakes up when it is powered up-Placing code in Program ROM-Executing a program byte by byte-ROM Width in the PIC18-Harvard architecture in the PIC-RISC architecture in the PIC-Features of RISC, PIC Instructions MOVWF instructions-COMF instruction-DECF instruction – MOVF instruction-ADDLW instruction and Status Register		**10**
		Total-	42

TEXT BOOKS:

1. Mazidi, Mazidi and D.MacKinlay –"8051 Microcontroller and Embedded Systems using Assembly and C "- 2006 Pearson Education Low Price Edition.

2. R.Theagarajan –"Microprocessor and Microcontroller "- Sci Tech Publication, Chennai

3. Kenneth J.Ayala –"8051 Microcontroller"

4. Muhammad Ali Mazidi ,Rolind D.Mckinlay,Danny Causey-PIC Microcontroller and Embedded systems using Assembly and C for PIC 18.

REFERENCE BOOKS: Myke Predko, -"Programming customizing the 8051 Microcontroller " Tata McGraw Hill

AUTO ELECTRONICS

	Theory			No of Period in one session: 42			Credits
Subject Code 2043503	No. of Periods Per Week			Full Marks	:	100	**03**
	L	**T**	**P/S**	**ESE**	:	70	
	03	—	—	**TA**	:	10	
				CT	:	20	

COURSE LEARNING OBJECTIVE:

Auto Electronics is introduced with the aim of providing necessary knowledge on automobiles that may help the students getting employed in automobile Industries.

OBJECTIVES:

1. Understand the basic concepts and components
2. Understand different ignition systems
3. Study about the lead acid battery, testing and lighting system
4. Study the sensor based electronic engine management and control devices

5. Study about advance Future Trends in Automobile Technique

UNIT	CONTENTS: THEORY	HOURS
1	**Automobile fundamentals** The engine-components- engine block, cylinder, crank shaft, piston, cam shaft, valves, intake system, ignition, exhaust, cooling system- Lubrication system-fuel feed system ignition system- spark plug- high voltage circuit and distribution- compression ignition system -steering system, Ackerman steering mechanism. Suspension systems. Fuel injection and Ignition system - Fuel injection-types- throttle body versus port injection- Fuel injectors- different types- - High pressure diesel fuel injection- Introduction to Electronic ignition system.	8
2	**Storage Battery, Charging and Lighting System:** Principle of lead acid cells, plates and their characteristics, construction, electrolyte, effect of temperature on electrolyte, specific gravity, capacity and efficiency, methods of charging from D.C. mains, defects and remedies of batteries, care of idle and new batteries. Recycling Process - Recent developments. D.C. Generators, Alternators -their Characteristics. Control, cutout, Electrical, Electro-mechanical and electronic regulators. Procedure for charging., details of head light and side light, LED lighting system, head light dazzling and preventive methods. Static and Dynamic Bending lights.	8

3	**Sensors and Engine Management Systems** Introduction to sensors and transducers-Types-Air flow rate sensor, Engine crankshaft angular position senor, Engine speed sensor, Timing sensor, Throttle angle sensor, Pressure sensor, Temperature sensors, Pressure sensor- Flow sensor, Exhaust gas oxygen sensors, Knock Sensor, Engine torque sensors, Automotive engine control actuators, Exhaust gas recirculation actuator. Electronic Engine Management System, Brake actuation warning system, flash system, oil pressure warning system, engine over heat warning system, air pressure warning system, speed warning system, door lock indicators, neutral gear indicator, horn design, permanent magnet horn, air & music horns. Wind shield wiper. Window washer, electronic instruments, dash board illumination and MIL.		10
4	**Automotive control systems and control components** Engine Control Objectives, Engine control functions, Fuel delivery systems, electronic fuel Ignition Systems– Emission control, Automotive Transmission Control Systems - Cruise control system, Antilock braking system (ABS), Tire-slip control, Active suspension, Traction control, Electronic Suspension system, Steering control, Stability control, Integrated engine control. Central locking, Air bags and seat belt tensioners. Voice warning system, Travel information system, GPS. Introduction to microchip –micro controller – block diagram – architecture – Introduction to AVR family IC – features, block diagram, architecture. Basics of embedded control and software.		10
5	**Recent trends in automobile technology** Electrical and Hybrid Vehicles, Introduction-Electric Vehicle development- system layout- basic system components- Electric battery solar cells- Rapid charging system-Motor drive system-fuel cell Electric vehicle- Hybrid vehicles- Parallel Hybrid Vehicle-CNG Electric hybrid vehicle. Vehicle Intelligence Introduction – Base structure- Vision based autonomous road vehicles- Architecture for vision system-Features- applications –image processing – Intelligent robot vehicles - obstacle detection, collision warning and avoidance system		6
		Total	42

Text Books:
1) Automobile engineering vol- 1, vol – 2, Kirpal singh, Standard publishers distributors New Delhi.
2) Automobile Engineering, G.B.S.Narang, Khanna Publishers, New Delhi.
3) Understanding Automotive Electronics, William B. Ribben, 6th edition Elsevier Science-2003

Reference Books:

1) Vehicle and Engine technology. Vol. I,Heinz Heisler, , ELBS
2) Automobile Engineering,R.B.Gupta, Satya Prakashan, New Delhi
3) Understanding Automotive Electronics,Fourth Edition,William B.Ribbens
4) Sensor and Transducers, Ronald K.Jurgen, SAE-2003
5) Electric and Hybrid-electric vehicles, Ronald K. Jurgen, SAE 2002

CAD/CAM

Subject Code 2043504	Theory			No of Period in one session: 42			Credits
	No. of Periods Per Week			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	03	—	—	TA	:	10	
				CT	:	20	

COURSE LEARNING OBJECTIVE:

As per the latest requirements in the industries this enables to learn the assistance of computer in the field of design and manufacturing areas. The application of material handling equipment is learnt based on the automation in the industries.

OBJECTIVES:

1. Understand the concept and requirement of the integration of the design and manufacturing.
2. Acquire knowledge about the computer assistance in the design process and analysis.
3. Understand the concepts of manufacturing with computer assistance in the shop floor.
4. Learn the principle and working of the CNC machines.
5. Understand the principle of latest manufacturing machines like EDM and RPT.
6. Learn the method of CNC programming with international codes.
7. Acquire the knowledge in the material handling equipment.

UNIT	CONTENTS: THEORY	Hours
I	**INTRODUCTION TO CIM AND COMPUTER AIDED DESIGN & ANALYSIS** **CIM:** Introduction of CIM – concept of CIM - evolution of CIM – CIM wheel – Benefits – integrated CAD/CAM. **CAD:** Computer Aided Design **–** Introduction – CAD definition – Shigley's design process – CAD activities – benefits of CAD. Types of CAD system – Host and terminal based CAD system - PC based CAD system – workstation-based CAD system – graphics workstation – CAD software packages. 2D&3D transformations – translation, scaling, rotation and concatenation. Geometric modeling: Techniques: Wire frame modeling – surface modeling – solid modeling: Boundary representation – Constructive Solid Geometry – Comparison. Graphics standard – Definition –Need - GKS – IGES – PHIGS – DXF. Cost involved in design changes – Concept of Design for Excellence (DFX) – Guide lines of Design for Manufacture and assembly (DFMA). **Finite Element Analysis:** Introduction – Development - Basic steps – Advantage.	10
II	**COMPUTER AIDED MANUFACTURING AND RAPID PROTOTYPING** **CAM:** Definition – functions of CAM – benefits of CAM – Group technology – Part families - Parts classification and coding - coding structure – Optiz system, MICLASS system and CODE System - process planning – CAPP – Types of **CAPP :** Variant type, Generative type – advantages of CAPP - production planning and control – computer integrated production management system – Master Production Schedule (MPS) – Capacity planning – Materials Requirement Planning (MRP) – Manufacturing Resources Planning (MRP-II)– Shop floor control system - Just in	10

	time manufacturing philosophy- Introduction to enterprises resources planning. Product Development Cycle – Sequential engineering – Concurrent engineering. Rapid proto typing: concept and applications – materials – types - Stereo lithography – laser sintering – Deposition Modeling - 3D printing.		
III	**CNC MACHINE AND COMPONENTS** **CNC Machines:** Numerical control – definition – components of NC systems – development of NC – DNC – Adaptive control systems – working principle of a CNC system – Features of CNC machines - advantage of CNC machines – difference between NC and CNC – Construction and working principle of turning centre – Construction and working principle of machining centers – machine axes conventions turning centre and machining centre – design considerations of NC machine tools. CNC EDM machine – Working principle of die sinking and wire EDM machines - Coordinate Measuring Machines: construction and working principles. **Components of CNC machine.** **Drives:** spindle drive – dc motor – Feed drives – dc servo motor and stepper motor – hydraulic systems – Slide ways – requirement – types – friction slide ways and anti friction slide ways - linear motion bearings – recirculation ball screw – ATC – tool magazine – feedback devices – linear and rotary transducers – Encoders - in process probing.	**10**	
IV	**PART PROGRAMMING** NC part programming – methods - manual programming – conversational programming – APT programming - Format: sequential and word address formats - sequence number – coordinate system – types of motion control: point-to-point, paraxial and contouring – Datum points: machine zero, work zero, tool zero NC dimensioning – reference points – tool material – tool inserts - tool offsets and compensation - NC dimensioning – preparatory functions and G codes, miscellaneous functions and M codes –interpolation: linear interpolation and circular interpolation - CNC program procedure. Part Program – macro – sub-program – canned cycles: stock – mirror images – thread cutting – Sample programs for lathe: Linear and circular interpolation - Stock removal turning – Peck drilling – Thread cutting and Sample programs for milling: Linear and circular interpolation – mirroring – sub program – drilling cycle – pocketing – Generating CNC codes from CAD models – post processing	**08**	
V	**FMS, AGV AND INTEGRATED MATERIAL HANDLING** Types of manufacturing - introduction to FMS – FMS components – FMS layouts – Types of FMS: flexible manufacturing cell – flexible turning cell – flexible transfer line – flexible machining systems – benefits of FMS - introduction to intelligent manufacturing system – virtual machining. Computer Integrated material handling – AGV: working principle – types - benefits – Automatic Storage and Retrieval Systems (ASRS).	**04**	
	Total	**42**	

Text books   :

1) CAD/CAM/CIM , R.Radhakrishnan, S.Subramanian, New Age International Pvt. Ltd.
2) CAD/CAM , Mikell P.Groover, Emory Zimmers, Jr.Prentice Hall of India Pvt., Ltd.
3) NC Programming, S.K.Sinha, Galgotia Publications Pvt. Ltd.

Reference Books:

1. CAD/CAM Principles and Applications, Dr.P.N.Rao, Tata Mc Graw Hill publishing Company Ltd.
2. CAD/CAM, Ibrahim Zeid, Mastering Tata McGraw-Hill Publishing Company Ltd., New Delhi.
3. Automation, Production Systems, and Computer-Integrated Manufacturing,
4. Mikell P. Groover, Pearson Education Asia.
5. Computer control of manufacturing systems,Yoram Koren, McGraw Hill Book.

EMBEDDED PROCESSORS

	Theory			No of Period in one session : 28			Credits
Subject Code 2043505A	**No. of Periods Per Week**			**Full Marks**	**:**	**100**	**02**
	L	**T**	**P/S**	**ESE**	**:**	**70**	
	02	—	—	**TA**	**:**	**10**	
				CT	**:**	**20**	

Course Learning Objectives:

Familiarization with modern engineering software tools and hardware equipment and will develop innovative thinking capabilities to foster research in Embedded System areas of related to Robotics engineering

Course Outcomes:

Upon completion of the course, students should possess the following skills:

1. To design the hardware and software required to implement an embedded processing system.
2. To take a problem statement and implement a solution using a combination of hardware and software while using a microprocessor/microcontroller.
3. To use the standard ports and interface devices on a typical microcontroller.
4. To write simple assembly language programs which utilize microcontroller.
5. To understand the general process of embedded system development

UNIT	CONTENTS: THEORY	HOURS
I	**INTRODUCTION:** ARM Design Philosophy, Registers, Program Status Register, Instruction Pipeline, Interrupts and Vector Table, Architecture Revision, ARM Processor Families, features, advantages & suitability in embedded application.	06
II	**ARM PROCESSOR PROGRAMMING:** Instruction set, programming in assembly language. Simple C Programs using Function Calls, Pointers, Structures, Integer and Floating-Point Arithmetic, Assembly Code using Instruction Scheduling, Register Allocation, Conditional Execution and Loops.	08
III	**ARM CORTEX PROCESSORS:** Introduction improvement over classical series and advantages for embedded system design. CORTEX A, CORTEX M, CORTEX R processors series, ARM-CM3 Based Microcontroller LPC1768: Features, Architecture, System Control, Clock & Power Control, GPIO, Pin Connect.	10
IV	**APPLICATIONS:** Block interfacing with RGB LED, Seven Segment, TFT Display, and Motor control using PWM. Concept of USB, CAN, and Ethernet based communication using microcontrollers	04
	Total-	28

TEXT BOOK:

1. Steve Furber, ―ARM System-on-Chip Architecture, Pearson Education, 2009.

2. Andrew Sloss, ―ARM System Developer's Guide, Morgan Kaufmann Publishers, 2009.

REFERENCES:

1. JonathanWValvano,Embedded Systems: Real-Time Operating Systems for the Arm Cortex-M3‖, Create space dependent publisher, 2012.

2. James Lang Bridge, ―Professional Embedded ARM Development‖, John Wiley & Sons, 2014.

3. Jonathan W. Valvano, Brookes / Cole ―Embedded Microcomputer Systems, Real Time Interfacing , Thomas Learning, 1999.

4. ARM architecture reference manual: - www.arm.c

A)	Course Code	: 2000505B / 2000508B /2000511B
B)	Course Title	: **Artificial Intelligence (Basics)**
C)	Pre- requisite Course(s)	:
D)	Rationale	:

Artificial intelligence is the theory and development of computer systems able to perform tasks such as, visual perception, speech recognition, decision-making etc. normally requiring human intelligence. Data analytics gives the basis of developing any artificial intelligence system.

The Python programming language is one of the most accessible programming languages, has several modules to write programs to solve Artificial Intelligence, Machine Learning, Data Analysis problems. Moreover, it has simplified syntax and versatile data structures and functions to speed up the code writing efficiently.

This course provides the basics for Artificial Intelligence problem solving techniques, data analytics and articulates the different dimensions of these areas. This course also provides the students the foundations for data analytics with python. The course explains data science techniques and the various Python programming packages required to prepare data for analysis, perform data analytics and create meaningful data visualization.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course , the students will be able to-

CO-1 Elaborate the use of Artificial Intelligence for the problem solving as Technological driver.

CO-2 Write Python Programmes for solving problems.

CO-3 Analyze given data by using NumPy package of Python.

CO-4 Analyze given data by using Pandas package of Python.

CO-5 Visualize given data set using Matplotlib.

F) **Suggested Course Articulation Matrix:**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)(if any)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1	-	2	2	-	-	-	1			
CO-2	-	3	3	3	-	-	2			
CO-3	-	3	3	3	-	-	2			
CO-4	-	2	3	3	-	-	2			
CO-5	-	3	3	3	-	-	2			

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G)   Scheme of Studies:

CourseCode	CourseTitle	Scheme of Studies (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (SW+ SL)	Total Hours (CI+LI+SW+SL)	Total Credits(C)
		L	T				
2000505B / 2000508B /2000511B	Artificial Intelligence (Basics)	02	-	04	02	08	05

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 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.

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

SL: Self Learning, MOOCS, spoken tutorials, open educational resources (OERs)

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

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

H)   Scheme of Assessment:

Course Code	Course Title	Scheme of Assessment (Marks)						Total Marks (TA+SWA+LA)
		Theory Assessment (TA)		Sessional Work Assessment (SWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Sessional Work Assessment (PSWA)	End Sessional Work Assessment (ESWA)	Progressive Lab Assessment(PLA)	End Laboratory Assessment (ELA)	
2000505B / 2000508B /2000511B	Artificial Intelligence (Basics)	30	70	20	30	20	30	200

Legend:

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

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

SWA: Sessional Work/ Term work& Self Learning Assessment (Includes assessment related to student performance in self learning, assignments, Seminars, micro projects, industrial visits, any other student activities etc.

Note: Separate passing is must for progressive and end semester assessment for both theory and practical.

Theory: 100 marks

Practical 50 marks

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), Sessional 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: [2000505B]

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)

TSO 1a. Elaborate the use of Artificial Intelligence
TSO 1b. Explain various technological Drivers of 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
	Unit-1.0. Artificial Intelligence
	   Artificial Intelligence: 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 of AI, Techniques used in AI, Perception, Understanding and Action**,** Technological drivers of modern AI
	   Knowledge: Definition, Knowledge Representation, objectives and requirements, practical aspects of representation, Components **Intelligent Agents**: Agents and Environments, Properties of environments, characteristics of agents, classification of agents
	   Problem Solving: Problem Formulation, Goal Formulation, State Space Search, Search Problem, Basic search algorithm, Search Tree, Search strategies – Uninformed and informed search, Breadth First Search, Depth First Search, Best First Search, 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 various operators in Python TSO 2e. Write program using conditional	**Unit-2.0 Python Programming** 2.1 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),	CO-2

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
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 TSO 2l. Describe procedure to Import Library and functions in the Python TSO 2m. Write program using Iterative statements.	mutable and immutable data types Operators: arithmetic operators, relational operators, logical operators, assignment operator, augmented assignment operators. Expressions, statement, type conversion & input/output: precedence of operators, expression, evaluation of expression. **Conditional and Iterative statements:** if, if-else, if-elif-else, for loop, range function, while loop, break and continue statements, nested loops **String, List, Tuples and Dictionary:** String: indexing, string operations (concatenation, repetition, membership & slicing), traversing a string using loops, built-in functions. Lists: introduction, indexing, list operations (concatenation, repetition, membership & slicing), traversing a list using loops, built-in functions, linear search on list of numbers and counting the frequency of elements in a list 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 **Python Functions:** 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) **Modules and Packages:** Importing module using 'import' Regular Expressions, Exception Handling, PyPI Python Package Index, Pip Python package manager, Importing Libraries and Functions	

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3a. Explain Data Analytics and its elements TSO 3b. Differentiate Data Analysis and Data Analytics TSO 3c. Explain the use of open source data TSO 3d.Differentiate Qualitative and Quantitative data analysis TSO 3e. Explain procedure to Install NumPy Library TSO 3f. Use NumPy library to perform various operations and functions on array TSO 3g. Write Programs using NumPy for array manipulations	**Unit-3.0 Data Analytics and Computing with NumPy** Data Analytics: 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. NumPy Library: Introduction, Installation, Ndarray: creating an array, intrinsic creation of an array, Data types, basic operations, aggregate functions, Indexing, slicing, Iterating, Conditions and Booleanarrays, Array manipulation: Joining, splitting, shape changing, sorting, Structured arrays, Reading and Writingarray data on a File.	CO-3
TSO 4a. Apply Pandas data structure for data analysis **TSO** 4b. Write Programs using Pandas to perform various operations and functions on series. **TSO** 4c. Perform various operation in a Data Frame columns and rows **TSO** 4d. Write Programme to read and write on CSV, XLS and Text data files **TSO** 4e. Apply various data cleaning operations and prepare data.	**Unit-4.0 Data Analysis with Pandas** Pandas data structures: Series, Declaration, selecting elements, assigning values, Filtering values, operations, mathematical functions, evaluating values, handling missing data, creating series from dictionaries, adding two series. Data Frame: Defining, selecting elements, assigning values, membership, deleting a column, filtering. Index Objects: Indexing, Re-indexing, Dropping, sorting and ranking, Descriptive Statistics Data Loading: Reading and Writing csv, xls, text data files, Data Cleaning and Preparation: Handling missing data, removing duplicates, replacing values,Vectorized String Methods, HierarchicalIndexing, Merging and Combining, Data aggregation and Grouping.	CO-4

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	**Unit-5.0 Data Visualization with Matplotlib** 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	CO-5

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	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.	

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

K) Laboratory (Practical) Session Outcomes (LSOs) and List of Practical [2000508B]

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
Use various data types and operators to solve given problem Use conditional and iterative statements for solving given problem	1	**Conditional and Iterative statements** 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
2.1Use string functions for performing various string operations	2	**String Handling** 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
Use list operations for concatenation, repetition & slicing Perform various operation in the Tuples Perform various operation in the dictionary	3	**List, Tuples and Dictionary** 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. 3e. Write a program to merge two dictionaries.	CO-2

4.1 Use built-in functions to solve given problem	4	**Python Functions** 4a. Write a function to reverse a string. 4b.Write a function to calculate the factorial of a	CO-2

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
4.2 Create user defined functions tosolve given problem		number.	
use basic data structure using NumPy Convert the list and tuple as NumPy array	5.	**Basic data structures in NumPy** 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
Create Arrays in Numpy using different intrinsic methods Performarithmetic operations and mathematical operations using arange and ones intrinsicmethod.	6	**Arrays in NumPy** 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 arange and ones intrinsic method. 6c. Check the results of mathematical operations like exp(), sqrt(), sin(), cos(), log(), dot() on an array created using arange intrinsic method.	CO-3
7.1　Apply aggregate functions on data by using Built-in functions in Numpy	7	**Built-in functions in NumPy.** 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(), corrcoef(), std())	CO-3
8.1 Handle multiple arrays by applying various operations on arrays	8	**Handling Multiple Arrays** 8a. Create two python NumPy arrays (boys, girls) each with the age of nstudents in the class. 8b. Get the common items between two python NumPy arrays. 8c. Get the positions where elements of two arrays match. 8d. Remove from one array those items that exist in another. 8e. Extract all numbers between a given range from a NumPy array.	CO-3

		9	**Indexing in NumPy**	
9.1	Apply indexing on the given set of data		9a. Load your class Mark list data from a csv file into an array.	CO-3
			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	

Practical/Lab Session Outcomes(LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
Create series using list and dictionary in pandas Print different values from series.	10	**Working with a Series using Pandas** 10a. Create a series using list and dictionary. 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 theseries.	CO-4
11.1 Perform various operation in aData Frame rows	11	**Working with Data Frame Rows** 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 fractionsof rows (use df. sample method) 11e. Count the number of rows with each unique value of variables 11f. Select nlargest and nsmallest values.11g. Order/sort the rows	CO-4
12.1 Apply different techniques tomerge and combine data	12	**Merge and combine data** 12a. Perform the append, concat and combinefirst 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

Create Linear Plot to identify various relation in the data using Matplotlib Create Scatter Plot to identify various relation in the data using Matplotlib	13	**Consider the Salary dataset, which contains 30observations consisting of years of workingexperience and the annual wage. Download thedata set from** https://www.kaggle.com/rohankayan/years-of- experience-and-salary-dataset 13a. Create a linear plot to identify the relationship between years of workingexperience and the annual wages withsuitable 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	CO-5

Practical/Lab Session Outcomes(LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
		of the Set osa 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.	

L) **Sessional Work and Self Learning: [2000511B]**

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

b. **Micro Projects:**

1. **Handing Two-dimensional array in NumPy**
   Download the data set from
   https://archive.ics.uci.edu/ml/machine-learning-databases/iris/iris.datahttps://www.kaggle.com/arshid/iris-flower-dataset

   a. Import iris dataset with numbers and texts keeping the text intact into python NumPy.
   b. Convert the 1D iris to 2D array (iris2d) by omitting the species text field.
   c. Find the number and position of missing values in iris2d's sepal_length
   d. Insert np.nan values at 20 random positions in iris 2d dataset
   e. Filter the rows of iris2d that has petal_length> 1.5 and sepal_length< 5.0

   Expected Outcome(Use various operations on two dimensional arrays in NumPy)

2. **Handling missing data and duplicates in Pandas**
   a. Identify rows with missing data (isnull(), notnull()) and replace NA/Null data with a given value.
   b. Drop rows and columns with any missing data (dropna(), dropna(1))
   c. Find duplicate values and drop duplicates.
   d. Fill the missing values using forward filling and backward filling.
   e. Replace the missing value with new value and write the dataframe to a CSV file in the local directory.

   Expected Outcomes (a. Identify missing data, b. Find Duplicates values, c. Write the dataframe to a CSV file in the local directory.)

3. **Working with Data Frame Columns**
   a. Create and print a Data Frame.
   b. Find the descriptive statistics for each column.
   c. Group the data by the values in a specified column, values in the index.
   d. Set Index and columns in a Data Frame.
   e. Rename columns and drop columns
   f. Select or filter rows based on values in columns.
   g. Select single and multiple columns with specific names

Expected Outcome (Perform various operation in a Data Frame columns)

4. **Indexing & Sorting in NumPy**
   a. Load your class Mark list data from a csv file into an array.
   b. Sort the student details based on Total mark.

c. Print student details whose total marks is greater than 250 using Boolean indexing.

Expected Outcomes (a. Sort the given set of data, b. Use indexing in an array)

5. **Array Slicing in NumPy**
   a. Load your class Mark list data into an array called "marks" to store students roll num, subject marks and result.
   b. Split all rows and all columns except the last column into an array called "features".
   c. Split the marks array into 3 equal-sized sub-arrays each for 3 different subject marks.
   d. Split the last column into an array "label".
   e. Delete the roll num column from the marks array and insert a new column student name in its place.
   Expected Outcome (Use array slicing in NumPy for the given set of data)

6. Consider the Iris dataset, where observations belong to either one of three iris flower classes.
   Download the data set from
   https://www.kaggle.com/arshid/iris-flower-dataset

   a. Visualize the Histogram for each feature (Sepal Length, Sepal Width, petal Length & petal Width) separately with suitable bin size and color.
   b. Plot the histograms for all features using subplots to visualize all histograms in one single plot. Save the plot as JPEG file.
   c. Plot the box plots for all features next to each other in one single plot. Perform 3D printing of plastic casing of inhaler used by Asthma patients and estimate the cost.

   Expected Outcomes (a. Plot the Histogram for the various features using subplot, b. Plot the box plots for all features next to each other in one single plot)

c. **Other Activities:**

1. **Lab Activities**
   - Install Python IDE and important Python Libraries
   - Install Anaconda and find the features of Jupyter Notebook.
   - Import various module using 'import '
   - Use Pip Python package manager.
   - Import Libraries and Functions in Python

2. **Seminar Topics:**
   - Technological rivers of modern Artificial Intelligence
   - Intelligent Agents and Environments in Artificial Intelligence
   - Various Search Strategies
   - Python for Data Science
   - Python Libraries and Packages used in data Science
   - Data Visualisation
   - Various data set available over Internet

3. **Self-learning topics:**
   - Use of AI in Engineering and Technology
   - Data Science and Machine Learning
   - Problem and Goal Formulation
   - Search strategies
   - Breadth First Search and Depth First Search
   - Back tracking Search

- N Queen and 8 Puzzle Problem

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

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

Legend:
* : Other Activities include self learning, seminar, visits, surveys, product development, software development etc.
**: Mentioned under point- (N)
: Mentioned under point-(O)
Note: For indirect assessment of COs, Course exit survey can be used which comprises of questions related to achievement of each COs.

N) **Specification Table for End Semester Theory Assessment:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be assessed to calculate CO attainment.

Unit Title and Number	Relevant COs Number(s)	Total Marks	ETA (Marks)		
			Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0. Artificial Intelligence	CO-1	15	7	5	3
Unit-2.0. Python Programming	CO-2	15	4	3	8
Unit-3.0. Data Analytics and Computing with NumPy	CO-3	14	3	3	8
Unit-4.0. Data Analysis with Pandas	CO-4	13	3	3	7
Unit-5.0. Data Visualization with Matplotlib	CO-5	13	3	3	7
	Total Marks	**70**	**20**	**17**	**33**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) **Specification Table for Laboratory (Practical) Assessment:**

SN	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA (%)	PDA (%)	
1.	Conditional and Iterative statements	CO-2	-	80	20
2.	String handling	CO-2	-	80	20
3.	List, Tuples and Dictionary	CO-2	20	70	10
4.	Python Functions	CO-2	-	80	20
5.	Basic data structures in NumPy	CO-3	-	80	20
6.	Arrays in NumPy	CO-3	-	80	20
7.	Built-in functions in NumPy.	CO-3	20	70	10
8.	Handling Multiple Arrays	CO-3	20	70	10
9.	Indexing in NumPy	CO-3	-	70	30
10.	Working with a Series using Pandas	CO-4	-	80	20
11.	Working with DataFrame Rows	CO-4	20	60	20
12.	Merge and combine data	CO-4	40	50	10
13.	Consider the Salary dataset, which contains 30 observations consisting of years of working experience and the annual wage.	CO-5	80	10	10
14.	Consider the Iris dataset, where observations belong to either one of three iris flower classes.	CO-5	80	10	10

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) **Instructional/Implementation Strategies:** Different Instructional/ ImplementationStrategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Group Discussion, Portfolio Based Learning, Live Demonstrations in Classrooms, Lab, Information and Communications Technology(ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources(OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Computer Systems	Desktop Computers with i3 processor, 16 GB RAM, 512 GB HDD	S.No. 1 to 14
2.	Online Python IDE	https://www.online-python.com/	S.No. 1 to 14
3.	Jupyter Notebook	Download from https://jupyter.org/	S.No. 1 to 14
4.	Pip Python package manager	Download Pip 22.3 From https://pypi.org/project/pip/	S.No. 1 to 14
5.	Various modules, Libraries and Packages	NumPy, Pandas, Matplotlib,PyPlot package	S.No. 1 to 14

R) Suggested Learning Resources:

(a) Suggested Books :

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Artificial Intelligence Basics - A Non-Technical Introduction	TomTaulli	Apress(2019)
2.	Fundamentals of artificial Intelligence	Chowdhary K. R	Springer 2020
3.	Artificial Intelligence A Modern approach	Stuart J. Russell and Peter Norvig	PrenticeHall 2010, 3rdEdition
4.	Introduction to Computing and Problem Solving using Python	E. Balagurusamy	McGraw Hill Education(India)Pvt. Ltd. 1st Edition /2016
5.	Learning Python Programming	Jeffrey Elkner, Allan B.Downey, Chris Meyers	Samurai Media Limited. 2016
6.	Python Programming	Ashok Namdev Kamthane and Amit Ashok Kamthane	McGraw Hill Education(India) Pvt.Ltd.2020, 2nd Edition
7.	Programming in Python	Dr. Pooja Sharma	BPB Publications 2017
8.	Taming Python By Programming	Jeeva ose	Khanna Book Publishing Co(P)Ltd , 2017, Reprinted2019
9.	Python Data Analytics	Fabio Nelli	Apress,2015
10.	Python for Data Analysis: Data Wrangling with Pandas, Numpy, and IPython	Wes McKinney	O'REILLY 2018,SecondEdition

(b) Suggested Open Educational Resources (OER):

1. NPTEL Web Content- Artificial Intelligence, Prof. P. Mitra, Prof. S. Sarkar, IIT Kharagpur URL: https://nptel.ac.in/courses/106/105/106105078/
2. https://www.learnpython.org
3. www.python.org
4. https://www.tutorialspoint.com/python

Note: Teachers are requested to check the creative commons licence status/ financial implications of the suggested OER, before use by the students.

(c)   Others: (If any)

Data Source:
- https://archive.ics.uci.edu/ml/machine-learning-databases/auto-mpg/
- https://archive.ics.uci.edu/ml/machine-learning-databases/iris/iris.data
- https://www.kaggle.com/arshid/iris-flower-dataset
- https://www.kaggle.com/rohankayan/years-of-experience-and-salary-dataset

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A) Course Code : **2000505C / 2000508C / 2000511C**

B) Course Title : **Internet of Things (Basic)**

C) Pre- requisite Course(s) : **Digital Electronics, Electronics Circuits, Fundaments of Computers and Computer networks**

D) Rationale:

The Internet of Things (IoT) is the upcoming field that has the capability to connect everything on the earth. This course focuses on the development of IoT concepts such as sensing, actuation with implementation of communication protocols.

The course also focuses on real life aspects of IoT and how to integrate it in real life projects. The course will simplify the concept of IoT by using the Node MCU board for IoT application development. In this course students will learn about the use of Node MCU and its applications as a beginner/intermediate in the field of IoT. Apart from this, students will learn about the APIs, by using which integration of features like send Email, WhatsApp messages and notification based on certain events in projects is possible. Overall, this course covers both hardware and software aspects of IoT with practical exposure.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Describe the functions of each block of the basic IoT system

CO-2 Explain communication protocol used in IoT and its applications

CO-3 Use appropriate sensors for the specific measurement through the IoT platform

CO-4 Explain APIs, client-server connections and its integration in real life applications.

CO-5 Build and test a complete, working IoT system involving prototyping, programming, and data analysis

F) **Suggested Course Articulation Matrix:**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs) (if any)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1	3	-	-	-	-	-	-			
CO-2	1	2	2	2	2	-	-			
CO-3	1	3	2	2	2	2	2			
CO-4	1	1	2	3	-	2	2			
CO-5	1	1	3	2	2	3	3			

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G) Scheme of Studies:

CourseCode	CourseTitle	Scheme of Studies (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (SW+ SL)	Total Hours (CI+LI+SW+SL)	Total Credits(C) (CI+LI+SW+SL)
		L	T				
2000505 C / 2000508 C / 2000511C	**Internet of Things (Basic)**	02	-	04	02	08	05

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 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.

SW: Sessional Work/Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCS, spoken tutorials, open educational resources (OERs)

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

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

H) Scheme of Assessment:

Course Code	Course Title	Scheme of Assessment (Marks)						Total Marks (TA+SWA +LA)
		Theory Assessment (TA)		Sessional Work Assessment (SWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment(ETA)	Progressive Sessional Work Assessment (PSWA)	End Sessional Work Assessment (ESWA)	Progressive Lab Assessment(PLA)	End Laboratory Assessment (ELA)	
2000505 C / 2000508 C / 2000511C	Internet of Things (Basic)	30	70	**20**	**30**	20	30	200

Legend:

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

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

SWA: Sessional Work/Term work& Self Learning Assessment (Includes assessment related to student performance in self learning, assignments, Seminars, micro projects, industrial visits, any other student activities etc.

Note: Separate passing is must for progressive and end semester assessment for both theory and practical.

Theory: 100 marks
Practical 50 marks

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), Sessional 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: [2000505C]

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	**Unit-1.0 Introduction to IoT** Basics of IoT, concepts of IoT, History of IoT Basic IoT System and its building blocks Various platforms for IoT (e.g. AWS, AZURE, GCP) Introduction to Python programming andIoT software 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	**Unit 2. IoT Communication protocols** Basics of given communication protocol along with its applications Explain Communication Protocols MQTT Bluetooth Low Energy ZigBee LoRa Wi-fi	CO-1 and C02
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.	**Unit-3.0 Sensors and Hardware for IoT** Sensors and Actuators, Transducers, Classifications of sensors, IoT Sensors Development Boards, classifications, and basics of wireless networks, WiFi libraries Introduction to node MCU, block diagram, functions, interfacing with sensors and publishing data on webserver Device integration with node MCU 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.	**Unit.4 IoT APIsand its Integration** Explain APIs and its use Explanation of given IoT APIs along with its applications MQTT, Broker, subscriber, publisher **REST** **SOAP** **4.5 JSON** **4.6 Programming API using Python**	**CO-1 and CO-4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.5.a. Differentiate between industrial IoT and IoT. 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.	**Unit. 5 IoT Applications**: - Industrial IoT and Internet of everything IoT for consumer electronics products IoT for Medical applications IoT for Agriculture IoT for security and Law enforcement	**CO-1 and CO-5**

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

K) Laboratory (Practical) Session Outcomes (LSOs) and List of Practical [2000508 C]

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSOs 1.1 List various IoT platforms. List Down broad features of given platforms. 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**
LSOs 2.1 Arduino connection with Arduino IDE. Connect Bluetooth with Arduino. verification of data communication with Bluetooth.	2.	Establish connectivity between various components of IoT. Establish connection between Arduinoand Bluetooth module. Establish connection using WiFi	**CO-2**
LSO 3.1 Measure the temperature of the given sensor. 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 POSTMAN Application.	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 various applications. LSO 5.2 Estimate the cost for components.	5.	Identify components for given project Estimate the cost to make Project working.	**CO-5**

L)   Sessional Work and Self Learning: [2000511C]

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

   b. **Micro Projects:**
      1. Prepare a report on IoT Systems using Internet data.
      2. Market survey to identify various types of IoT sensors and its pricing.
      3. Interface IR sensor with Arduino and send the data to Arduino cloud.
      4. Send IoT data using Node MCU to things Speak cloud.
      5. Interface Bluetooth module with Arduino and send data using the Bluetooth module.

   c. **Other Activities:**
      1. Seminar Topics: - "Future of IoT"
                          "Technologies for IoT ", "Smart City and IoT"
      2. Visit to industry for latest IoT setup in industrial process.
      3. Surveys of market for availability of various types of sensors and its pricing.
      4. Product Development: Development of projects for real life problem solution using IoT.
      5. Software Development: various open source platform operations.

   6. **Self-learning topics:**
      1. IoT hardware and their use for various applications
      2. IoT sensors technical specifications
      3. IoT enabled services

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

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Sessional Work Assessment (SWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Sessional Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	10%	10%	20%	--	33%	10%	20%
CO-2	15%	10%	20%	--	33%	15%	20%
CO-3	30%	30%	20%	--	34%	15%	20%
CO-4	20%	30%	20%	50%	--	30%	20%
CO-5	25%	20%	20%	50%	--	30%	20%
Total Marks	30	70	20	20	10	20	30
			50				

Legend:
* **:**   Other Activities include self learning, seminar, visits, surveys, product development, software development etc.
**:   Mentioned under point- (N)
 # :   Mentioned under point-(O)
Note: For indirect assessment of COs, Course exit survey can be used which comprises of questions related to achievement of each COs.

N) **Specification Table for End Semester Theory Assessment:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be assessed to calculate CO attainment.

Unit Title and Number	Relevant COs Number(s)	Total Marks	ETA (Marks)		
			Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0. Introduction to IoT	CO-1	5	3	2	-
Unit-2.0. IoT Communicationprotocols	CO-2	9	4	3	2
Unit-3.0. Sensors and Hardware for IoT	CO-3	19	5	6	8
Unit-4.0 IoT APIs and its Integration	CO-4	19	5	5	9
Unit-5.0. IoT Applications	CO-5	18	3	6	9
	Total Marks	70	20	22	28

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) **Specification Table for Laboratory (Practical) Assessment:**

SN	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA (%)	PDA (%)	
1.	Prepare a list of platforms used for IoT.	CO-1	60	30	10
2.	Prepare a list of features of above IoT platforms.	CO-1	60	30	10
3.	Prepare a list of features provided by python language for IoT applications.	CO-1	60	30	10
4.	Establish connectivity between various components of IoT.	CO-2	60	30	10
5.	Establish connection between Arduino and Bluetooth module.	CO-2	60	30	10
6.	Establish connection using WiFi	CO-2	70	20	10
7.	Publish data on the IoT platform.	CO-3	70	20	10
8.	Measure the temperature of a remotely located temperature sensor Using IOT based temperature data-monitoring system.	CO-3	60	40	10
9.	Measure the humidity of a remotely located temperature sensor Using IOT based temperature data-monitoring system.	CO-3	60	40	10
10.	Measure the pressure of a remotely located temperature sensor Using IOT based temperature data-monitoring system.	CO-3	60	40	10
11.	Publish the data using Mqtt	CO-4	60	30	10
12.	Download and Configure POSTMAN Applications	CO-4	60	30	10
13.	Verify REST APIs through POSTMAN.	CO-4	60	30	10
14.	Verify JSON APIs through POSTMAN.	CO-4	60	30	10
15.	Verify SOAP APIs through POSTMAN.	CO-4	60	30	10
16.	Identify components for given project	CO-5	50	40	10
17.	Estimate the cost to make Project working.	CO-5	50	40	10

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) **Instructional/Implementation Strategies:** Different Instructional/ Implementation Strategies may be appropriatelyselected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources(OER), MOOCs etc.

Q) **List of Major Laboratory Equipment, Tools and Software:**

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1	Bluetooth Modem-BlueSMiRF Silver	Sparkfun Bluetooth modem	As mentioned above list
2	Postman Software	Open-source downloadable	
3	Node MCU board	Generic	
4	IoT free cloud	Arduino cloud/Thing Speak/Blynk	
5	ATAL Lab Package-1 Package-2 Package-4	As per the list as address below ATAL Equipment list' (http://aim.gov.in/guidelines-for-school.php).	

R) **Suggested Learning Resources:**

(a) **Suggested Books** :

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1	Internet of Things Architecture and Design Principles	Raj Kamal	Mc Graw Hills, New Delhi ISBN 13: 978-93-90722-38-4

2	Internet of things (IoT) : technologies, applications, challenges and solutions	Edited By BK Tripathy , J Anuradha	CRC Press ,ISBN 9780367572921, June 30, 2020	
3	Internet-of-Things (IoT) Systems: Architectures, Algorithms, Methodologies	by Dimitrios Serpanos & Marilyn Wolf	Springer; 1st ed. 2018 edition (17 January 2018)	
4	Custom Raspberry Pi Interfaces: Design and build hardware interfaces for the Raspberry	Pi by Warren Gay	Apress; 1st ed. edition (23 February 2017), ISBN-10 : 9781484224052, ISBN-13 : 978-1484224052	
5	'Learning Internet of Things',	Peter Waher	Packt Publishing, 2015, ISBN 9781783553532, https://lib.hpu.edu.vn/handle/123456789/31693	
6	Sensors, Actuators and Their Interfaces,	N. Ida	Scitech Publishers, 2014.	

(b) Suggested Open Educational Resources (OER):

1. nptel.iitm.ac.in/courses/.../IIT.../lecture%2023%20and%2024.htm
2. en.wikipedia.org/wiki/Shear and moment diagram
3. www.freestudy.co.uk/mech%20prin%20h2/stress.pdf
4. www.engineerstudent.co.uk/stress_and_strain.html
5. https://www.iit.edu/arc/workshops/pdfs/Moment_Inertia.pdf
6. https://www.veritis.com/blog/aws-vs-azure-vs-gcp-the-cloud-platform-of-your-choice/
7. https://wiki.python.org/moin/TimeComplexity
8. www.engineerstudent.co.uk/stress_and_strain.html
9. https://www.iit.edu/arc/workshops/pdfs/Moment_Inertia.pdf
10. Amini, P. (2014). Sulley: Pure Python fully automated and unattended fuzzing frame- work.
11. https://github.com/OpenRCE/sulley

Note: Teachers are requested to check the creative commons licence status/ financial implications of the suggested OER, before use by the students.

(c) Others: (If any)

1. Learning Packages
2. Users' Guide
3. Manufacturers' Manual
4. Lab Manuals

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A)	Course Code	:	2000505D / 2000508D / 2000511D
B)	Course Title	:	Drone Technology (Basics)
C)	Pre- requisite Course(s)	:	
D)	Rationale	:	

Rapid technological innovation has provided users cutting-edge products at affordable prices. Traditionally, drones had been limited to military use due to high costs and technical sophistication. In recent years, the drone has number of commercial uses and are also proving to be extremely beneficial in places where a man cannot reach or is unable to perform in a timely and efficient manner. Today, drones are used in construction, photography, agriculture, defense, environmental studies and monitoring and other industriesto protect the skies, repopulate forests and accomplish much more on a huge scale. This course will acquaintthe student with the basic drone technology and applicable drone rules and regulations in India. Consideringthat the main operational areas of diploma holders, it is essential that he should be exposed to basic drone designing, programming, operating, maintaining and using them safely.

E)   Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the students will be able to-

CO-1   Operate a drone safely by applying appropriate drone rules and regulations.

CO-2   Design the structure of drone with drone components and equipment.

CO-3   Interface flight controller board with sensors, ESC and radio communication unit in drone technology.

CO-4   Use drone simulator and identify different types of ports and connectors of drone.

CO-5   Use python programming while drone designing.

F)   Course Articulation Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)(if any)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1	2	-	-	-	3	-	2			
CO-2	3	2	3	3	-	-	-			
CO-3	3	2	3	3	-	-	-			
CO-4	2	-	-	2	-	3	2			
CO-5	-	2	2	3	-	-	-			

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G) Scheme of Studies:

CourseCode	CourseTitle	Scheme of Studies (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (SW+ SL)	Total Hours (CI+LI+SW+SL)	Total Credits(C) (CI+LI+SW+SL)
		L	T				
2000505D / 2000508D / 2000511D	Drone Technology (Basics)	02	-	04	02	08	05

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 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.

SW: Sessional Work/Term work(includesassignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCS,spoken tutorials, open educational resources (OERs)

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

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

H) Scheme of Assessment:

Course Code	Course Title	Scheme of Assessment (Marks)						Total Marks (TA+SWA+LA)
		Theory Assessment (TA)		Sessional Work Assessment (SWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment(ETA)	Progressive Sessional Work Assessment (PSWA)	End Sessional Work Assessment (ESWA)	Progressive Lab Assessment(PLA)	End Laboratory Assessment (ELA)	
200505D / 200508D / 200511D	3D Printing and Design (Basics)	30	70	**20**	**30**	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

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

Note: Separate passing is must for progressive and end semester assessment for both theory and practical.

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), Sessional 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: [2000505D]

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)

TSO 1a. Describe the various historical evolutionary steps of drone technology
 	
TSO 1b. Explain Drone motion based on principle of aerodynamics.
 	
TSO 1c. Classify different types of drones and make chart of its application, advantages and disadvantages.
 	
TSO 1d. Develop attitude to follow proper rules and regulations of drones flying in India.
 	
TSO 1e. Explore future prospects of drones in India.
	Unit-1.0 Introduction to Drone Technology
	Introduction to Drones and UAV
	• Definition
	• History
	• Drone in Indian aspect
	Introduction to Flight Dynamics
	  Various types of Drones and their
	  respective Applications
	• Multirotor drones
	• Fixed wing structure
	Drone flights using an understanding of FAA
	• DGCA
	• Digital sky platform
	• RPTO
	1.5 Drone regulations-No drone zones
		CO-1

TSO 2a. Explain the use and function of different types of Drone components. TSO 2b. Select suitable drone frame and propellers for given application. TSO 2c. Explain working principle and function of different sensors used in drone technology. TSO 2d. Write use of Gyro sensor and Accelerometer in drone. TSO 2e. Describe different types and capacity of Battery used in various drone applications. TSO 2f. State the selection criteria of motor for given drone application. TSO 2g. Write advantage of BLDC motors in making of Drones.	**Unit-2.0 Drone and its components** Drones components • Drone frame • Propellers Sensors • Gyro sensor and Accelerometer • Speed and Distance Sensor • Temp sensor • Barometer • TOF Sensor Battery • Types and Capacity Motors • Motor types • Motor capabilities • Application of BLDC motors in drones	CO-2

TSO 3a. Explain four types of motion used in drone's operation.	**Unit-3.0 Drone controller and motion**	**CO-3**
TSO 3b. Describe the working and applications of Electronic speed controller.	Propulsion and Vertical Motion Controller and Flying Instructions	
TSO 3c. Explain the working principle of Flight controller unit used in drone.	• Electronic speed Controller (ESC) • Flight Controller Board(FCB)	

Major Theory Session Outcomes (TSOs)		Units	Relevant COs Number(s)
TSO 3d.	Explain Radio communication unit used in drone.	Radio Communication • Transmitter and Receiver for radio signal	
TSO 3e.	Explain the communication of Flight controller board with motor, ESC and sensors with suitable diagram		
TSO 4a.	Describe utility of different communication port used in drone.	**Unit-4.0 Connections and Interfaces of Devices in Drone and Drone Simulator** Communication Port • PWM • RS232, RS422, RS485 • UART • CAN • I2C Different types of connectors and its specification Drone Simulator software Drone simulator Hardware	**CO-4**
TSO 4b.	Identifydifferent types of connectors and write their specifications.		
TSO 4c.	Explain the use of drone simulator software and hardware.		
TSO 5a.	Write basic code in Python.	**Unit-5.0 Introduction to Python for Drone** Python programing refreshers for IoT, AI and Drone Integration of devices with cloud services Microsoft Azure, AWS	**CO-5**
TSO 5b.	Explain structure and components of a Python program.		
TSO 5c.	write syntax of loops and decision statements in Python.		
TSO 5d.	Explain steps to create functions and pass arguments in Python.		

K) Laboratory (Practical) Session Outcomes (LSOs) and List of Practical [2000508D]

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
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	16.	Build and Run functions for specific application and pass arguments in Python.	CO-5

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 16.3 Debug code of function in python			
LSO 17.1 Identify python programming steps to interface drone components.	17.	Write basic programming in python to interface different component of Drones.	CO-5, CO-3
LSO 17.2 Identify error in python program			
LSO 17.3 Debug the given python program			

L) Sessional Work and Self Learning: [2000511D]

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

d. **Self learning topics:**
   1. History of Drones
   2. Drone in Indian aspect
   3. Drone regulations
   4. Principle of aerodynamics for Drones
   5. Drone simulator

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

Course Evaluation Matrix				
Theory Assessment (TA)**		Sessional Work Assessment (SWA)	Lab Assessment (LA)#	
Progressive Theory Assessment	End Theory Assessment (ETA)	Sessional Work & Self Learning Assessment	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)

COs	(PTA) Class/Mid Sem Test		Assignments	Micro Projects	Other Activities*		
CO-1	10%	10%	10%	--	10%	-	-
CO-2	30%	30%	30%	33%	30%	30%	30%
CO-3	30%	30%	30%	34%-	30%	30%	30%
CO-4	15%	10%	15%	-	15%	20%	20%
CO-5	15%	20%	15%	33%	15%	20%	20%
Total Marks	30	70	20	20	10	20	30
				50			

Legend:
* : Other Activities include seminar, visits, surveys, product development, software development etc.
**: Mentioned under point- (N)
 # : Mentioned under point-(O)
Note: To calculate CO attainment 80% weightage of direct assessment tools and 20% of indirect assessment tools may be taken.

N) **Specification Table for End Semester Theory Assessment:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be assessed to calculate CO attainment.

Unit Title and Number	Relevant COs Number(s)	Total Marks	ETA (Marks)		
			Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0. Introduction to Drone Technology	CO-1	08	03	02	03
Unit-2.0. Drone and its component	CO-2	20	05	07	08
Unit-3.0. Drone controller and motion	CO-3	20	05	07	08
Unit-4.0. Connections and Interfaces ofDevices in Drone and Drone Simulator	CO-4	08	03	02	03
Unit-5.0. Introduction to Python for Drone	CO-5	14	04	04	06
	Total Marks	70	20	22	28

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) **Specification Table for Laboratory (Practical) Assessment:**

S.No	Laboratory Practical Titles	Relevant COs Number(s)	PLA #/ELA # (Marks)		
			Performance		Viva-Voce (…%)
			PRA (…%)	PDA (…%)	
1.	Determine the strength of materials used in drones frame.	CO-2	60	30	10
2.	Determine the strength of materials used in drones Propellers.	CO-2	60	30	10
3.	Test different parameters of batteries used in drones	CO-2	50	40	10
4.	Test motors suitable for specific Drone application.	CO-2	50	40	10
5.	Test and measure Gyro sensor and Accelerometer and their characteristics.	CO-2	50	40	10
6.	Test different sensors and their characteristics with Microcontroller based Flight controller board.	CO-2, CO-3	50	40	10

| 7. | Determine thrust/torque of motor by changing different drone motion | CO-2, CO-3 | 60 | 30 | 10 |

S.No	Laboratory Practical Titles	Relevant COs Number(s)	PLA #/ELA # (Marks)		
			Performance		Viva-Voce (…%)
			PRA (…%)	PDA (…%)	
8.	Test and troubleshoot Flight control board (FCB).	CO-3	60	30	10
9.	Test and perform communication of Flight control board (FCB) with sensor	CO-3, CO-2	60	30	10
10.	Test and perform communication of Flight control board (FCB) with motor.	CO-3, CO-2	60	30	10
11.	Test and perform communication of Flight control board with ESC.	CO-3	60	30	10
12.	Test and perform communication of Flight control board with RF transceiver.	CO-3	60	30	10
13.	Test Hardware assembly for drone.	CO-4 CO-3	50	40	10
14.	Perform different motion in drone simulator.	CO-4	50	40	10
15.	Build and run loops and decision statements for specific application in Python.	CO-5	50	40	10
16.	Build and Run functions for specific application and pass arguments in Python.	CO-5	50	40	10
17.	Write basic programming in python to interface different component of Drones.	CO-5, CO-3	50	40	10

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) **Instructional/Implementation Strategies:** Different Instructional/ImplementationStrategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology(ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources(OER), MOOCs etc.

Q) **List of Major Laboratory Equipment, Tools and Software:**

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Drone Frame	Tricopter/Quadcopter/Hexacopter	1-13
2.	Propellers	10X4.5 CW/Others	1-13
3.	Speed Sensor	3.3 or 5.0Vdc	1-13
4.	Distance Sensor	5Volt operating voltage	1-13
5.	Gyro sensor and Accelerometer	5Volt operating voltage	1-13
6.	Barometer	Altitude tracking, temp range from 25°C to 40°C	1-13

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
7.	TOF Sensor	Accurate ranging up to 4 m, Fast ranging frequency up to 50	1-13
8.	Battery	Lithium Polymer Battery,2200mAH/others	1-13
9.	Motor	BLDC,1000kv or 1000RPM/volt	1-13
10.	Electronic speed Controller (ESC)	30 Amp,2-4s or cell	1-13
11.	Flight Controller Unit	KK 2.1.5/ ArdupilotAPM 2.8/ Pixhawk/others	1-13
12.	Transmitter and Receiver for radio signal	4 channels/6 Channels, 2.4 GHz & 5.8 GHz	1-13
13.	Drone Simulator Software	RC flight simulator	14
14.	Python Software	Hardware required-More than 4 GB RAM, 64 bit CPU preferable	15,16,17

R) Suggested Learning Resources:

(a) Suggested Books :

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Make: Getting Started with Drones: Build and Customize Your Own Quadcopter	Terry Kilby&Belinda Kilby	Shroff/Maker Media, First edition 2016, ISBN-978-9352133147
2.	Agricultural Drones: A Peaceful Pursuit	K R Krishna	Apple Academic Press,1st edition 2018, ISBN-978-1771885959
3.	DIY Drone and Quadcopter Projects: A Collection of Drone-Based Essays, Tutorials, and Projects	Editors Of Make	Shroff/Maker Media; First edition 2016, ISBN-978-9352133994
4.	Building Multicopter Video Drones: Build and fly multicopter drones to gather breathtaking video footage	Ty Audronis	Packt Publishing Limited; Illustrated edition,2014,ISBN-978-1782175438
5.	The Complete Guide to Drones	Adam Juniper	Ilex Press, Extended 2nd Edition,2018 ISBN-9781781575383

(b) Suggested Open Educational Resources (OER):

1. https://nptel.ac.in/courses/101104073
2. https://en.wikipedia.org/wiki/Unmanned_aerial_vehicle
3. https://www.scienceabc.com/innovation/what-is-drone-technology.html
4. https://www.dronezon.com/learn-about-drones-quadcopters/what-is-drone-technology-or-how-does-drone-technology-work/
5. https://www.youtube.com/watch?v=OWaXIK9sHeE
6. https://books.google.co.in/books?id=2M0hEAAAQBAJ&printsec=copyright&redir_esc=y#v=onepage&q&f=false

Note: Teachers are requested to check the creative commons licence status/ financial implications of the suggested OER, before use by the students.

(c)   Others: (If any)

1.   Learning Packages

2.   Users' Guide
3.   Manufacturers' Manual
4.   Lab Manuals

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A)	**Course Code**	:	**2000505E / 2000508E / 2000511E**
B)	**Course Title**	:	3D Printing and Design (Basics)
C)	**Pre- requisite Course(s)**	:	Computer aided Modeling
D)	**Rationale**	:	

Additive manufacturing (AM) or Additive layer manufacturing (ALM) is the industrial production name for 3D Printing. 3D Printing is a process that makes solid objects from a digital model. It involves depositing material either metal, powdered plastic, or liquid in thin layers (2D) to get a 3D object. This basic course on 3D Printing tries to develop understanding of the process of making real object from digital model in the students. It also covers the software/hardware required, various materials used for 3D Printing and details about printing process parameters. The knowledge gained through this course will help the students to takeup advanced course on 3D Printing in next semester.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Develop CAD models for 3D Printing.

CO-2 Import and Export CAD data in .STL file format to generate GCODE file.

CO-3 Select suitable 3D Printing material for given applications.

CO-4 Select suitable 3D Printing process for given situations.

CO-5 Produce products using most popular FDM/SLA/SLS 3D Printing processes.

F) **Course Articulation Matrix:**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs) (if any)		
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	3	-	3	2	-	-	2			
CO-2	3	2	-	2	-	-	-			
CO-3	3	3	-	2	3	-	-			
CO-4	3	3	-	2	-	-	-			
CO-5	3	-	3	3	-	3	2			

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G) **Scheme of Studies:**

CourseCode	Course Title	Scheme of Studies (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (SW+ SL)	Total Hours (CI+LI+SW+SL)	Total Credits(C)
		L	T				
2000505E / 2000508E / 2000511E	3D Printing and Design (Basics)	02	-	04	02	08	05

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 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.

SW: Sessional Work/Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, open educational resources (OERs)

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

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

H)   Scheme of Assessment:

Course Code	Course Title	Scheme of Assessment (Marks)						Total Marks (TA+SWA+LA)
		Theory Assessment (TA)		Sessional Work Assessment (SWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Sessional Work Assessment (PSWA)	End Sessional Work Assessment (ESWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2000505E / 2000508E / 2000511E	3D Printing and Design (Basics)	30	70	**20**	**30**	20	30	200

Legend:

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

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

SWA: Sessional Work/Term work & Self Learning Assessment (Includes assessment related to student performance in self learning, assignments, Seminars, micro projects, industrial visits, any other student activities etc.

Note: Separate passing is must for progressive and end semester assessment for both theory and practical.

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), Sessional 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: [2000505E]

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain CAD-CAM and related terminologies. *TSO 1b.* Convert the given CAD file format into others. *TSO 1c.* Transfer the given CAD data to CAM facilities. *TSO 1d.* Classify 3D Printing processes. *TSO 1e.* List the advantages of additive manufacturing processes over	**Unit-1.0 Additive Manufacturing Introduction and CAD** CAD-CAM and its integration CAD- Part and Surface modeling CAD file formats Additive v/s Conventional Manufacturing processes Process chain for 3D Printing Classification of 3D Printing Processes Product design and prototyping	CO1

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
conventional manufacturing processes. TSO 1f. List typical steps involved in 3D printing of an object from digital model. TSO 1g. Explain reverse engineering steps for 3D Printing.	1.8 Reverse Engineering for 3D Printing	
TSO 2a. Explain the given STL interface terminology. TSO 2b. Use the given alternative 3D printing interface. TSO 2c. Generate STL file for the given CAD file. TSO 2d. Repair the given STL file. TSO 2e. Apply part orientation and support techniques for the given situation. TSO 2f. Perform slicing of the given CAD model using the given slicing software. TSO 2g. Generate tool path using simulation software for the given situation.	**Unit-2.0 Data Preparation for 3D Printing** STL interface Specification, STL data generation, STL data Manipulation, Advantages and limitations of STL file format, Open files, Repair of STL files, Alternative 3D Printing interfaces Part orientation and support generation, Factors affecting part orientation, Various models for part orientation determination, The function of part supports, Support structure design, Automatic support structure generation Model Slicing and Contour Data organization, Direct and adaptive slicing:Identification of peak features, Adaptivelayer thickness determination Tool path generation	CO1, CO2
TSO 3a. Explain the given 3D Printing processe. TSO 3b. List process parameters of the given 3D Printing processes. TSO 3c. Select 3D Printing materials for the given application. TSO 3d. Select 3D Printing processes among FDM, SLS, SLA for given application with justification.	**Unit-3.0 Additive Manufacturing Techniques** Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology, Direct Energy Deposition Process parameter, Process Selection for various applications 3D Printing materials and selection Comparison between FDM, SLS, SLA	CO3, CO4
TSO 4a. Identify various Aerospace, Electronics, Health care, Automotive, Construction, Food processing, Machine tool components that can be 3D Printed. TSO 4b. Estimate the cost and time of 3D printing of the given component.	**Unit-4.0 Application of 3D Printing** 4.1 Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defense, Automotive, Construction, Food Processing, Machine Tools	CO3, CO4

TSO 5a. Select suitable 3D Printer and software for the given application with justification. *TSO 5b.* Analyze the effect of given 3D printing process parameters using 3D printer software simulation. *TSO 5c.* List steps to perform 3D scanning of the given object.	**Unit-5.0 3D Printers and Software and Scanners** Construction details and working of established 3D printers for plastics parts only: Stereolithography (SLA), Selective Laser Sintering (SLS), and Fused DepositionModeling (FDM). Accuracy, Precision and Tolerance in 3D printing. 3D Printer software- Fusion 360,	CO4, CO5

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 5d. Repair 3D scanned digital model. *TSO 5e.* Set different 3D printing process parameters to get a sound plastic component.	Solidworks, Onshape, Tinkercad, Ultimaker Cura, MeshLab, Simplyfy 3D, Repetier host, Slic3r, etc. – use and operation of anyone. 3D Scanners and working. Producing a part using FDM, SLA and SLS 3D Printer	

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

K) Laboratory (Practical) Session Outcomes (LSOs) and List of Practical [2000508E]

Practical/Lab Session Outcomes(LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use CAD software. *LSO 1.2.* Prepare digital models of simple 3D entities.	1.	Develop digital models of following simple components using any CAD software: • Nut • Bolt • Network cable Jack • Coat button • Spoon	CO1
LSO 2.1. Prepare digital models of complex 3D entities and assemblies.	2.	Develop digital models of following assemblies using any CAD software: • Connecting Rod • Piston • Electric switch • Bathroom Tap • Mouse	CO1
LSO 3.1. Surf web for downloading readymade free CAD models. *LSO 3.2.* Convert one CAD file format into another.	3.	Download three digital CAD models freely available on web in different formats and then convert them into .stl/obj format.	CO1
LSO 4.1. Use the given Slicing software for 3D Printing. *LSO 4.2.* Perform slicing operation on the given digital model.	4.	Perform slicing operation on one digital model available under each Pr. No.1, 2 and 3.	CO2
LSO 5.1. Use the available 3D printing software. *LSO 5.2.* Selection of 3D printing process and performance parameters.	5.	Analyse the effect of different process parameters, materials on printing time, material required, surface finish, etc. through simulation using 3D printing software on sliced models available from Pr. No. 4	CO3, CO4, CO5
LSO 6.1. Produce single plastic components using available 3D printer. *LSO 6.2.* Perform post processing operations on printed component.	6.	Print one single component on available 3D printer with PLA/ABS material	CO3, CO4, CO5
LSO 7.1. Select appropriate layer thickness, tolerance, fit. *LSO 7.2.* Produce an assembly of plastic	7.	Print one assembly on available 3D printer with PLA/ABS material	CO3, CO4, CO5

Practical/Lab Session Outcomes(LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
components using available 3D printer.			
LSO 8.1. Choose suitable material for printing flexible structure (assembly of same small pieces to give flexible fabric effect). LSO 8.2. Choose suitable design/shape to create a flexible type structure. LSO 8.3. Produce flexible plastic structure using available 3D printer.	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
LSO 9.1. Selection of 3D printing process parameters.	9.	Change printing process parameters and repeat experiment number 6.	CO4, CO5
LSO 10.1. Use of available 3D scanner. LSO 10.2. Develop 3D digital model using scanning approach. LSO 10.3. Modeling of complex 3D objects using 3D scanning.	10.	Scan the given complex component using available 3D Scanner.	CO5
LSO 11.1. Produce a complex plastic structure using available 3D printer and scanner. LSO 11.2. Apply Reverse Engineering approach to exactly 3D print an existing real object.	11.	Print the 3D scanned digital model of Pr. No. 10 on available 3D printer with PLA/ABS material	CO5

L) Sessional Work/Term Work and Self Learning: [2000511E]

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.

c. **Other Activities:**
   1. Seminar Topics:
      - Commercially available 3D printers and software.
      - Strength of 3D printed Plastic components as compared to Die cast Plastic components.
      - Properties of PLA and ABS 3D printing materials.
      - Reverse engineering application of 3D Printing.
   2. Visits: Visit nearby tool room/industry with 3D Printing facilities. Prepare report of visit with special comments of 3D printing technique used, material used, single component/batch production/mass

production and cost of printed component.

3. Self learning topics:
    *   3D printing of flexible plastic components.
    *   3D printing of micro/mini components.
    *   Conversion of CAD file formats into IGES.
    *   3D scanning process.

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

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Sessional Work Assessment (SWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Sessional Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	10%	15%	-	-	20%	20%
CO-2	10%	20%	10%	25%	-	10%	20%
CO-3	15%	20%	15%	25%	33%	15%	20%
CO-4	30%	20%	30%	25%	33%	15%	20%
CO-5	30%	30%	30%	25%	34%	40%	20%
Total Marks	30	70	20	20	10	20	30
			50				

Legend:
*   :   Other Activities include self learning, seminar, visits, surveys, product development, software development etc.
** :   Mentioned under point- (N)
 #   :   Mentioned under point-(O)
Note: For CO attainment calculation Indirect assessment tools like Course exit survey need to be used which comprises of questions related to achievement of each COs.

N) **Specification Table for End Semester Theory Assessment:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be assessed to calculate CO attainment.

Unit Title and Number	Relevant COs Number(s)	Total Marks	ETA (Marks)		
			Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Additive Manufacturing Introduction and CAD	CO1	12	4	3	5
Unit-2.0 Data Preparation for 3D Printing	CO1, CO2	10	4	2	4
Unit-3.0 Additive Manufacturing Techniques	CO3, CO4	19	5	5	9
Unit-4.0 Application of 3D Printing	CO3, CO4	10	2	3	5
Unit-5.0 3D Printers and Software and Scanners	CO4, CO5	19	5	5	9
Total Marks		70	20	18	32

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) **Specification Table for Laboratory (Practical) Assessment:**

SN	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA (%)	PDA (%)	
1.	Develop digital models of following simple components using any CAD software: • Nut • Bolt • Network cable Jack • Coat button • Spoon	CO1	30	60	10
2.	Develop digital models of following assemblies using any CAD software: • Connecting Rod • Piston • Electric switch • Bathroom Tap • Mouse	CO1	40	50	10
3.	Download three digital CAD models freely available on web in different formats and then convert them into .stl/obj format.	CO1	30	60	10
4.	Perform slicing operation on one digital model available under each Pr. No.1, 2 and 3.	CO2	30	60	10
5.	Analyse the effect of different process parameters, materials on printing time, material required, surface finish, etc. through simulation using 3D printing software on sliced models available from Pr. No. 4	CO3, CO4, CO5	30	60	10
6.	Print one single component on available 3D printer with PLA/ABS material	CO3, CO4, CO5	30	60	10
7.	Print one assembly on available 3D printer with PLA/ABS material	CO3, CO4, CO5	30	60	10
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	40	50	10
9.	Change printing process parameters and repeat experiment number 6.	CO4, CO5	40	50	10
10.	Scan the given complex component using available 3D Sanner.	CO5	40	50	10
11.	Print the 3D scanned digital model of Pr. No. 10 on available 3D printer with PLA/ABS material	CO5	30	60	10

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) **Instructional/Implementation Strategies:** Different Instructional/ ImplementationStrategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources(OER), MOOCs etc.

Q)   List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	High end computers	Processor Intel Core i7 with Open GL Graphics Card, RAM 32 GB, DDR3/DDR4, HDD 500 GB, Graphics Card NVIDIA OpenGL 4 GB, OS Windows 10	All
2.	Parametric Computer Aided Design software	CATIA/Solid works/NX/Creo **OR** Available with CoE	1,2
3.	3D printer	Fused Deposition Modelling system with complete accessories; Build Volume-300 x 300 x 300mm or Higher; Layer Thickness-0.1 – 0.4 **OR** Available with CoE	6, 7, 8, 10
4.	3D Printing Material	ABS/PLA **OR** Available with CoE	6, 7, 8, 10
5.	3D Printing software	Latest version of software like: Cura/PrusaSlicer/ideaMaker/Meshmixer/MeshLab **OR** Available with CoE	3,4
6.	Post processing equipments and tools	Deburring tools (tool handle & deburring blades), Electronic Digital Caliper, Cleaning Needles, Art knife set, Long nose pliers, Flush cutters, Wire brush, Nozzle cleaning kit, Tube cutter, Print removal spatula, Needle file, Cutting mat, Glue stick, Wire stripper etc.	6, 7, 8, 10
7.	3D Scanner and Processing software	Handheld 3D scanner, Accuracy up to 0.1 mm, Resolution up to 0.2 mm, Real time onscreen 3D model projection and processing, Wireless technology with an inbuilt touch screen and battery, Extended field of view for capturing both large and small objects, Processing Software **OR** Available with CoE	10

R)   Suggested Learning Resources:

(a)   Suggested Books :

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing	Lan Gibson, David W. Rosen, Brent Stucker	Springer, 2010 ISBN: 9781493921133
2.	Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing	Andreas Gebhardt,	Hanser Publisher, 2011 ISBN: 156990507X, 9781569905074

3.	3D Printing and Design	Sabrie Soloman	Khanna Publishing House, Delhi ISBN: 9789386173768
4.	3D Printing and Rapid Prototyping- Principles and Applications	C.K. Chua, Kah Fai Leong	World Scientific, 2017 ISBN: 9789813146754
5.	Getting Started with 3D Printing: A Hands-on Guide to the Hardware, Software, and Services Behind the New Manufacturing Revolution	Liza Wallach Kloski, Nick Kloski	Make Community, LLC; 2nd edition, 2021 ISBN: 9781680450200
6.	Laser-Induced Materials and Processes for Rapid Prototyping	L. Lu, J. Fuh, Y.S. Wong	Kulwer Academic Press, 2001 ISBN: 9781461514695

(b)   Suggested Open Educational Resources (OER):

1.   https://onlinecourses.nptel.ac.in/noc21_me115/preview
2.   https://archive.nptel.ac.in/courses/112/104/112104265/
3.   https://www.youtube.com/watch?v=b2Od4YHcLAQ
4.   https://www.youtube.com/watch?v=EF8CNR-gcXo
5.   https://www.academia.edu/41439870/Education_Resources_for_3D_Printing
6.   https://www.think3d.in/landing-pages/beginners-guide-to-3d-printing.pdf
7.   https://all3dp.com/1/types-of-3d-printers-3d-printing-technology/

Note: Teachers are requested to check the creative commons licence status/ financial implications of the suggested OER, before use by the students.

(c)   Others: (If any)

1.   3D Printing Projects DK Children; Illustrated edition, 2017
2.   The 3D Printing Handbook: Technologies, design and applications Ben Redwood, Filemon Schöffer, Brian Garret, 3D Hubs; 1st edition, 2017
3.   3D Printer Users' Guide
4.   3D Printer Material Handbook
5.   Lab Manuals

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A)	Course Code	: 2000505 F / 2000508 F /2000511F
B)	Course Title	: Industrial Automation (Basic)
C)	Pre- requisite Course(s)	: Basic Mechanical Engineering, Basic Electrical Engineering, Digital Electronics and Basic programming skills
D)	Rationale	:

The technological education and research scenario, all over the world, is turning towards a multidisciplinary one. The present scenario is different as compared to the recent past in the sense that the engineering disciplines are now dilating instead of diverging. The primary reason being that the current technological designs are of highly complex and inter-interdisciplinary nature involving synergistic integration of many aspects of engineering knowledge base. Industrial automation has become an essential part of every modern industry. Automation helps industry to increase the productivity, quality, accuracy and precision of industrial processes. Stiff competition, higher quality standards and growing concerns of safety & environmental damage have pushed the Industrial sector to adapt state-of-the-art Automation Techniques for effective utilization of resources and optimized performance of the plants. Today engineer is needed to meet the requirements of designing appropriate automation systems. They should have the knowledge of different fields like PLC and PID based Controller, Instrumentation, Networking, Industrial Drives, SCADA/HMI, High speed data acquisition, etc., to become a successful automation engineer. The discipline Automation is enormous in magnitude. The students passing this course will gain basic understanding about industrial automation and will be prepared to take up the advance course in Industrial automation in next semester.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the students will be able to-

CO-1 Apply principles and strategies for automation for a given situation.

CO-2 Use sensors and input devices as per given situation.

CO-3 Test the given PLC for its functionality.

CO-4 Use actuators and output devices as per given situation.

CO-5 Test the working of various types of control system and controllers

F) **Suggested Course Articulation Matrix:**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs) (if any)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1 Apply principles and strategies for automation for a given situation	3	2	-	2	2	-	2			
CO-2 Use sensors and input devices as per	3	2		2			2			

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs) (if any)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
the requirement.			2		-	-				
CO-3 Test the given PLC for its functionality.	3	2	2	2	2	-	2			
CO-4 Use actuators and output devices a per given situation.	3	2	2	2	2	-	2			
CO-5 Test the functionality of various types of control system and controllers	3	2	2	2	-	-	2			

Legend: High (3), Medium (2), Low (1) andNo mapping (-)

G) Scheme of Studies:

CourseCode	Course Title	Scheme of Studies (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (SW+ SL)	Total Hours (CI+LI+SW+SL)	Total Credits(C) (CI+LI+SW+SL)
		L	T				
2000505 F / 2000508 F/ 2000511F	Industrial Automation (Basic)	02	-	04	02	08	05

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 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.

SW: Sessional Work (includesassignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCS,spoken tutorials, open educational resources (OERs)

C: Credits.

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

H)   Scheme of Assessment:

Course Code	Course Title	Scheme of Assessment (Marks)						Total Marks (TA+SWA+LA)
		Theory Assessment (TA)		Sessional Work Assessment (SWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Sessional Work Assessment (PSWA)	End Sessional Work Assessment (ESWA)	Progressive Lab Assessment(PL	End Laboratory Assessment (ELA)	
2000505F / 2000508F /2000511F	Industrial Automation (Basics)	30	70	20	30	20	30	200

Legend:

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

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

SWA: Sessional Work/ Term work& Self Learning Assessment (Includes assessment related to student performance in selflearning, assignments, Seminars, micro projects, industrial visits, any other student activities etc.

Note: Separate passing is must for progressive and end semester assessment for both theory and practical.

Theory: 100 marks

Practical 50 marks

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), Sessional 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 attainmentof 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 need to be integrated.

J)   Theory Session Outcomes (TSOs) and Units: [2000505 F]

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.1.a Describe Industry 4.0 and its component TSO.1.b Explain different types of automation systems TSO.1.c Identify the type of automation used in a given industry TSO.1.d Analyze the working of industrial processes and products for automation. ==TSO.1.e Select principles and strategies for automation for a given situation using 4R's and 1U== TSO.1.f Select criteria for factory automation and processes automation for a given industry. TSO.1.g Describe briefly different systems used for industrial automation. TSO.1.h Describe IOT, IIOT and role of robots with respect to automation.	**Unit-1.0Overviewof Industrial Automation** Introduction to Industry 4.0 and its components, Issues and challenges in automation Need of automation in industries, Principlesand strategies of automation, factory automation, process automation Basic elements of an automated system, Structure of Industrial Automation Advanced automation functions, Levels of automations Industrial control Systems- Process andDiscrete system Types of automation system: Fixed, Programmable, Flexible IntegratedAutomation and its application Different systems used for Industrial automation: PLC, HMI, SCADA, DCS, Drives. Introduction to Internet of Things (IoT) and Industrial Internet of Things (IIOT) and its application in Automation. Role of robots in automation and its components.	CO1 Apply principles and strategies for automation for a given situation.
TSO.2.a Explain PLC and list its advantages over relay systems. TSO.2.b Distinguish between PLC and a PC, PLC and dedicated controllers. TSO.2.c List the types of PLCs and brands available in the market. TSO.2.d Describe the function of each block of a PLC with the help of a block diagram. TSO.2.e Describe the basic sequence of operation of a PLC with a simple example. TSO.2.f Explain different PLC programming languages with simple examples. TSO.2.g Describe a simple PLC programming using ladder logic specifying I/O addressing TSO.2.h List the applications of PLC	**Unit-2.0Fundamentals of PLC** Introduction to PLC, evolution of PLC • Comparison of PLC and Personal Computer (PC) • Comparison of PLC and dedicated controllers like PAC and CNC • Types of PLC – Fixed, Modular and their types • Different brands of PLCs available in the market Building blocks of PLC -CPU, Memory organization, Input-Output modules (Discreteand Analog) Specialty I/O Modules, Power supply PLC programming languages with simple examples: • Functional Block Diagram (FBD), • Instruction List. • Structured text, • Sequential Function Chart (SFC), • Ladder Programming PLC I/O addressing in ladder logic Simple programming example using ladderlogic Applications of PLC: Traffic light control, Elevator control, Motor sequencing control, Tank level control, temperature control, Conveyor system	CO2 Use sensors and input devices as per given situation.

Major Theory Session Outcomes (TSOs)	Unit s	Relevant COs Number(s)
	control	
TSO.3.a Identify the commonly used input field devices in PLC installations along with their symbols. TSO.3.b Draw symbol of various switches used in PLC installations describing the function of each switch. TSO.3.c Identify the various digital input devices used in a PLC installation. TSO.3.d Identify the commonly used sensors as input field devices found in PLC installations. TSO.3.e Describe the working of different types of discrete sensors giving their applications. TSO.3.f Describe the working of different types of advanced sensors giving their applications. TSO.3.g Select Sensors as per the given requirement for ecofriendly automation	**Unit 3 – Sensors and Input field devices** Analog input devices-Electromagnetic relays, Contactors, Motor starters, Manually operated Switches Toggle switch, pushbutton switch, knife switch andselector 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 • Proximity sensors- Inductive, Capacitive,Optical and ultrasonic Advanced sensors- Construction and workingof • Temperature sensors- Thermistor,Thermocouple and Resistance temperature Detector (RTD) • Liquid level sensor -Capacitive andUltrasonic • Force -Strain/Weight sensors • Flow sensors – turbine flow sensor • Pressure sensors- Linear VariableDifferential Transformer (LVDT) • Inclination sensor -Inclinometer • Acceleration sensor- Accelerometer • Angular and linear position sensor	**CO 3** Test the given PLC forits functionality

TSO.4.a Classify the actuators. TSO.4.b Describe the construction and working of a given actuator. TSO.4.c Explain the basic principle of operation of a given actuator. TSO.4.d Differentiate betweenhydraulic and pneumatic actuators TSO.4.e Explain the basic principle of operation of a given control valve. TSO.4.f Select actuators and valves as per the given requirement for ecofriendly automation. TSO.4.g Develop different hydraulic and pneumatic circuits for simple application. TSO.4.h Identify the commonly used output field devices in PLC installations TSO.4.i Draw the symbol of various	**Unit 4- Actuators and output devices** Introduction to actuators, Classification of actuators Mechanical actuators -Translational and rotational motion, kinematic chains,cams, gears, belt and chain drives, bearings Hydraulic and Pneumatic actuators- linear and rotary actuators, single and double actingcylinder, directional, process and pressure control valves Electrical actuators • Electromechanical actuators Construction, working and application of Stepper motors, AC/DC Servo motors, BLDC Motor (Very brief) • Electrohydraulic actuators- Construction, working and application of Electro- hydrostatic actuator (EHA), ON/OFF Electro-hydraulic Rotary Actuator (E2H90, Control Valve	**CO 4** Use actuatorsand output devices as per given situation**.**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	4.6 Magnetic actuators- Construction, working principle and application of Moving coil actuators, moving magnet actuator, Moving iron actuator Selection criteria of actuators 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.	**Unit 5– Control system** 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 • Proportional Controller(P Controller) • Integral Controller (I Controller) • Derivative controller (D- Controller) • P-I Controller • P-D Controller • PID Controller	**CO5** Test the working of various types of control system and controllers

K) Laboratory (Practical) Session Outcomes (LSOs) and List of Practical [2000508 F]

Practical/Lab Session Outcomes (LSOs)	S.No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSOs 1.1 Identify various building blocks and major automation components in a given robotic system LSOs 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**
LSOs 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	
LSOs 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**

LSOs 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	
LSOs 2.3 Test the analog input and output lines of the given PLC.	6.	Identify Analog input and output lines of a PLC	
LSOs 2.4 Test the digital input and outlines of the given PLC.	7.	Identify digital input and output lines of a PLC	
LSOs 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 sensorused to detectdifferent types of materials	9.	Identify different types of digital inductive proximity sensor and its use	CO3
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 its use	
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 its use	
LSO 3.5. Use thermistor to measure temperature of a given material	13.	Identify different types of thermistor 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 parameter conversion of a Thermocouple	
LSO 3.7. Use RTD to control the temperature of an oven	15.	Observe different types of RTDs used in 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 flow measurement	
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 load cell used in industries for force/weight measurement	

LSOs 4.1 Design and actuate pneumatic circuit for lift control LSOs 4.2 Design a pneumatic system that rivets the pockets on jeans LSOs 4.3 Design pneumatic circuit to open and close the security gate and control the speed. LSOs 4.4 Design a circuit for speed control of hydraulic motor meter out circuit by using 4/3 DC valve. LSOs 4.5 Design a circuit for speed control of double acting cylinder meter in by using 4/2 dc solenoid valve. LSOs 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	
LSOs 4.7 Direct acting of hydraulic motor	20.	Operate hydraulic motor	
LSOs 4.8 Operate stepper motor and control the motor by changing number of steps, the direction of rotation and speed.	21.	Operate stepper motor	
LSOs 4.9 Identify the components of thermal and magnetic actuators available in the laboratory. LSOs 4.10 Use thermal and magnetic actuators	22.	Thermal and magnetic actuators	
LSOs 5.1 Test the output response of a open loop closed loop and feed forward path	23.	Analyze the given system to study open loop, closed loop and feed forward path.	CO5
LSOs 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	
LSOs 5.3 Build and test the response of a second order system for a step input usingCRO.Also mark various parameters	25.	Analyze the given second order system and its transfer function and output response	
LSOs 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.	
LSOs 5.5 Test the Output response pf a P+I+D based level control system.	27.	Analyze the given water level control system with P+I+D control.	

L) Sessional Work and Self Learning: [2000511 F]

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.

c. **Other Activities:**
1. Seminar Topics- PLC architecture, Different types of sensors, Industrial Applications of PLC and SCADA
2. Visits – Visit any industry with full or semi automation and prepare a report on type of automation used.
3. Surveys-Carry out a market/internet survey of PLC and prepare the comparative technical specifications of any one type of PLC (Micro or Mini) of different manufacturer.
4. Product Development- Develop a prototype automatic railway crossing system
   Software Development- Download any open-source software for PLC and install on your laptop/PC and carry out basic PLC programming
5. Surveys – carry out market survey for different types of electrical actuators available and prepare the comparative technical specifications of electrical actuators used in industries.
6. Visit industry and prepare a report on different types of hydraulic and pneumatic circuits used by the industry in the given section, components used, power requirement, output achieved and maintenance activities required.

d. **Self-learning topics:**
1. Use of PLC for different industrial applications
2. Use of sensors in commercial field
3. Use of sensors in home automation
4. Compare Specifications of PLCs of different manufacturers of any one type PLC

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

COs	Scheme of Assessment (Marks)								
	Theory Assessment (TA)					Lab Assessment (LA)			
	Progressive Theory Assessment (PTA)# Class/Mid Sem Test	End Theory Assessment (ETA)**	Sessional Work & Self Learning Assessment (SWA)			Progressive Lab Assessment (PLA)			End Laboratory Assessment (ELA)#
			Assignments(s)	Micro Projects	Other Activities*	Process Assessment (PRA)	Product Assessment (PDA)	Viva-Voce	
CO-1	15 %	20%	20 %	100	10 %	45%	35 %	100%	20 %
CO-2	20 %	20%	20 %		15 %	45%	35 %		20 %
CO-3	25 %	20%	20 %		15 %	45%	35 %		20 %
CO-4	25 %	20%	20 %		30 %	45%	35 %		20 %
CO-5	15 %	20%	20 %		30 %	45%	35 %		20 %
Total Marks	20	70	4	4	2	8	8	4	30

Legend:
* :   Other Activities include seminar, visits, surveys, product development, software development etc.
**:   Mentioned under point- (N)
 # :   Mentioned under point-(O)
Note: To calculate CO attainment 80% weightage of direct assessment tools and 20% of indirect assessment tools may be taken.

N)   **Specification Table for End Semester Theory Assessment:** The course teacher has to decide and use appropriate assessment strategy and its weight age in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be assessed to calculate CO attainment.

Unit Title and Number	Relevant COs Number(s)	Total Marks	ETA (Marks)		
			Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Overview of Industrial Automation	CO1	12	4	6	4
Unit-2.0 Fundamentals of PLC	CO2	17	5	6	6
Unit-3.0 Sensors and Input field devices	CO3	16	4	6	6
Unit-4.0 Actuators and output devices	CO4	15	4	5	6
Unit- 5.0 Control system	CO5	10	3	4	4
Total Marks		70	20	27	26

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Specification Table for Laboratory (Practical) Assessment:

S.NO	Laboratory Practical Titles	Relevant COs Number(s)	PLA #/ELA # (Marks)		
			Performance		Viva-Voce (10 %)
			PRA (45%)	PDA (45%)	
1.	Identify major automation components in a given system	CO1	45 %	35 %	20%
2.	Analyze given traditional machine in the laboratory for and identify the steps and components required to automate it.	CO1	45 %	35 %	20%
3.	Use Scada software for simple application	CO1	45 %	35 %	20%
4.	Observe various parts and front panel indicators of a PLC	CO2	45 %	35 %	20%
5.	Observe different types of switches and their symbols sensors, lamp, alarm, motor, fan used in a PLC	CO2	45 %	35 %	20%
6.	Identify Analog input and output lines of a PLC	CO2	45 %	35 %	20%
7.	Identify digital input and output lines of a PLC	CO2	45 %	35 %	20%
8.	Practice using PLC to control various digital and analog output devices	CO2	45 %	35 %	20%
9.	Identify different types of digital inductive proximity sensor and its use	CO3	45 %	35 %	20%
10.	Identify different types of digital capacitive proximity sensor and its use	CO3	45 %	35 %	20%
11.	Identify different types of digital optical proximity sensor and its use	CO3	45 %	35 %	20%
12.	Identify different types of digital ultrasonic proximity sensor and its use	CO3	45 %	35 %	20%
13.	Identify different types of thermistor and its use	CO3	45 %	35 %	20%
14.	19. Observe the conversion of temperature to electric parameter conversion of a Thermocouple.	CO3	45 %	35 %	20%
15.	Observe different types of RTDs used in industries for temperature measurement	CO3	45 %	35 %	20%
16.	Observe different types of flow sensors used in industries for flow measurement	CO3	45 %	35 %	20%
17.	Observe different types of pressure sensors used in industries for pressure measurement	CO3	45 %	35 %	20%
18.	Observe the different types of load cell used in industries for force/weight measurement	CO3	45 %	35 %	20%
19.	Design and actuate pneumatic/ hydraulic circuit for the given situation	CO4	45 %	35 %	20%
20.	Operate hydraulic motor	CO4	45 %	35 %	20%
21.	Operate stepper motor	CO4	45 %	35 %	20%
22.	Thermal and magnetic actuators	CO4	45 %	35 %	20%
23.	Analyze the given system to study open loop, closed loop and feed forward path.	CO5	45 %	35 %	20%

| 24. | Analyze the given first order system and its | CO5 | 45 % | 35 % | 20% |

S.NO	Laboratory Practical Titles	Relevant COs Number(s)	PLA #/ELA # (Marks)		
			Performance		Viva-Voce (10 %)
			PRA (45%)	PDA (45%)	
	transfer function and output response				
25.	Analyze the given second order system and its transfer function and output response	CO5	45 %	35 %	20%
26.	Analyze the given water level control system with on-off, Proportional control.	CO5	45 %	35 %	20%
27.	Analyze the given water level control system with P+I+D control.	CO5	45 %	35 %	20%

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubricsneed to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) **Instructional/Implementation Strategies:** Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and CommunicationsTechnology(ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) **List of Major Laboratory Equipment, Tools and Software:**

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	SCADA software (reputed make like Allen Bradley, Siemens etc.,)	Ready-to-use symbol library, React and respond in real-time, Real time monitoring, Friendly, manageable, secure, extensible, Easy-to-use, easy to implement, Easy configuration, simplified maintenance, Communication with PLC, easy and flexible alarm definition, data collection and analysis for new and existing systems, easy-to-use for report generation, open access to historical data, different packages available with input/output structure. Open source software SCADA software: like Ellipse/FTVSE/Wonderware/ open SCADA can also be used	3
2.	Universal PLC Training System with HMI (Of reputed make such as Allen bradely, Siemens, etc.,) Compatible with SCADA software	Human Machine Interface (HMI) display, PLC with 16 digital inputs, 16 digital outputs with RS232 communication facility. Open platform to explore wide PLC and HMI applications. Industrial look & feel. Toggle switches, push to ON switch, proximity sensor, visual indicator, audio indicator, and DC motor. Experiments configurable through patch board. Powerful instruction sets. Several sample ladder and HMI programs. PC based ladder and HMI programming. Extremely easy and student friendly software to develop different programs. Easy downloading of programs. Practice troubleshooting skills. Compact tabletop ergonomic design. Robust construction. PLC gateway for cloud connectivity. Open source software like Ladder logic simulator, Pico soft Simulator, Logixpro simulator, Simple EDA tools can also be used	4,5,6,7,8

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
3.	Proximity sensors kit	The kit should comprise of the following proximity sensor - Inductive Proximity Sensor, Capacitive Proximity Sensor, Magnetic Sensor, Optical Sensor, Audio and LED indicator for the object detection. Along with learning material	9,10,11,12
4.	Temperature transducer kit	Temperature Transducers Test Bench includes different types of temperature sensors including bimetallic strip, RTD, thermocouple, thermistor, RTD/thermocouple temperature display and thermistor, temperature display, heater, fan, switches and its indicator.Separate heater and fan chamber with stand. On panel digital voltmeter, digital ammeter, RTD/thermocouple temperature display, NTC temperature display, toggle switch for heater and fan with indicator, experiments configurable through patch board, heavy duty Test bench, castor wheel (with locking mechanism) is provided at legs of Test bench so that it can be easily moved, enhanced electrical safety consideration.	12,13,14
5.	Pressure transducer kit	Pressure transducer kit should include different types ofpressure sensors including capacitive pressure transducer, load cell, bourdon tube pressure gauge, and pressure vessel.Pressure vessel with pressure gauge, safety valve, non returning valve bourdon gauge and capacitive transducer and air compressor, on panel digital voltmeter, digital ammeter, 4-20ma display, 0- 10V DC display, toggle switch for compressor, load cell with suitable weight, experiments configurable through patch board, self - contained, bench-mounting arrangement, castor wheel (with locking mechanism) is provided at legs of Test bench so that it can be easily moved, enhanced electrical safety consideration. Detailed experiment manual should be supplied with the kit.	16
6.	Flow sensor kit	Turbine flow sensor kit	15
7.	Strain Gauge kit	The kit should provide study of Strain Gauge and their application for measurement of Strain. It should help to study bridge configuration of Strain Gauge and the signal conditioning circuits required to measure strain. It should use cantilever beam arrangement to produce strain on Strain Gauge.The StrainGauges are firmly cemented to the cantilever at the point where the strain is to be measured. Weights are placed on free end of cantilever. Strain developed changes the resistance of Strain Gauge which is detected by full bridge configuration. It should comprise of Seven-segment LED display showing strain in micro strain units. Different weights should be provided to perform linearity and sensitivity experiments. Detailed experiment manual should be supplied with the kit. Test-points to observe input output of each block, onboard gain and offset null adjustment, built in DC Power Supplies, 3½ digits LED display, onboard Cantilever arrangement, high repeatability andreliability The kit should be capable of performing following experiments: • Measuring strain using strain gauges and cantilever assembly. • Determination of linear range of operation of strain measurement. • Determination sensitivity of the kit	17
8.	Cut sections of pumps, actuators, valves and	Suitably cut and mounted on a sturdy base to show the internal details.	18

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
	accessories used in hydraulic systems		
9.	Working models of pumps, actuators, valves and accessories used in hydraulic systems	Working models mounted on sturdy base to demonstrate the operation.	18
10.	Working models of pumps, actuators, valves and accessories used in pneumatic systems	Working models mounted on sturdy base to demonstrate the operation.	18
11. 8	Oil Hydraulic trainer	Mounted on sturdy base fitted with all standard units and accessories to create various hydraulic circuits. Hydraulic trainer with simulation software Pneumatic trainer with simulation software • Filter Regulator Combination with Lubricator (FRL Unit) with pressure gauge , Junction Box with slide valve, Push Button Valve , 3/2 NC Roller lever valve ,3/2 NC Roller lever valve ,5/2 Double external pilot operated valve, 5/2 External pilot operated valve with spring return , 5/2 Hand lever with spring return, 5/2 Hand lever valve with detent – for maintained pilot operation of a SAC , 5/2 Valve with Lever head, 5/2 Value with Mushroom head , Flow control valve – Metering IN & OUT , Shuttle Valve (OR valve) , Quick Exhaust Valve with Quick coupler plug • Double Acting Cylinder (DAC) with Quick coupler socket (with accessories: Screw driver – for cushioning adjustment), Single Acting Cylinder (SAC), Swivel fitting assembly with Quick coupler plug, Multi distributor fittings (for cascading circuit designing) • Single Solenoid Valve with Spring Return (with LED), Double Solenoid Valve (with LED), Magnetic Reed Switch, Magnetic Reed Switch, Relay Logic Unit – 2C/0-3 relays, Electrical Push Button Unit, Electrical Selector Switch Unit, Timer	18
12.	Pneumatic Trainer	Mounted on sturdy base fitted with all standard units and accessories to create various Pneumatic circuits. Pneumatic trainer with simulation software • Filter Regulator Combination with Lubricator (FRL Unit) with pressure gauge, Junction Box with slide valve • Push Button Valve, 3/2 NC Roller lever valve, 3/2 NC Roller lever valve, 5/2 Double external pilot operated valve (Memory valve) • 5/2 External pilot operated valve with spring return, 5/2 Hand lever with spring return, 5/2 Hand lever valve with detent, 5/2 Valve with Lever head ,5/2 Value with Mushroom head, Flow control valve, Shuttle Valve (OR valve), AND valve • Quick Exhaust Valve with Quick coupler plug, Double Acting Cylinder (DAC) with Quick coupler socket, Single Acting Cylinder (SAC), Swivel fitting assembly with Quick coupler plug • Aluminum Profile Table Top, Profile Table Top, Miniature Double Acting Cylinder (DAC), Single Solenoid Valve with Spring Return, Double Solenoid Valve (with LED) • Magnetic Reed Switch, Relay Logic Unit – 2C/0-3 relays, Electrical Push Button Unit, Electrical Selector Switch Unit (Black Selector – 1 no, Green Push Button – 1 no), Timer, Simulation software	18

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
13.	Advanced Electro - Hydraulic and Electro - Pneumatic Hardware systems with work stations and simulation software	• Electro - Hydraulic and Electro - Pneumatic Hardware systems with PLC and simulation software • Profile plate, Frame with Castor Wheels, Filter, Lubricator, Regulator with pressure gauge, Hand Slide Valve, Connection component set, Plastic Tubing, Power Supply & cables, Pressure Gauge, 3/2 Way double solenoid valve	18
14.	Output devices	Servomotor, DC motor, AC motor, stepper motor, Conveyer Belt control by PLC, water level control etc.	18,19,20
15.	Thermal actuators	Hot-And-Cold-Arm Actuators, Chevron-Type Actuators	21
16.	Magnetic actuators	Moving Coil Controllable Actuators, Moving Iron Controllable Actuator	21
17.	Open and closed loop control system kit	Open and closed loop system kit should be able to measure the output response using CRO	22
18.	First and second order control system	First and second order system with input and output terminals provision	23,24
19.	Process control system with feed forward path kit	Process control system with feed forward path kit with input and output terminals provision	22
20.	PID Controller Test Bench	PID Controller Test Bench is a complete setup to control process through two-point (on/off) and three-point (PID) controllers. Industrial PID controller with RS485 communication facility, Thermocouple temperature sensor, Float switch for detection of water level, Temperature measurement and control, User friendly software, USB Interface, Heavy duty Test bench,Electrical control panel, Leak proof sturdy piping and tanks, SS Sump tank for inlet and outlet of water, Enhanced electrical safety considerations, Caster wheel (with locking mechanism) at the legs of Testbench for easy movement.	25,26

R)   Suggested Learning Resources:

(a)   Suggested Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Introduction to Programmable Logic Controllers	Dunning, G.	Thomson /Delmar learning, New Delhi, 2005, ISBN13: 9781401884260
2.	Programmable Logic Controllers	Petruzella, F.D.	McGraw Hill India, New Delhi, 2010, ISBN: 9780071067386
3.	Programmable Logic Controllers	Hackworth, John; Hackworth, Federic	PHI Learning, New Delhi, 2003, ISBN: 9780130607188
4.	Industrial automation and Process control	Stenerson Jon	PHI Learning, New Delhi, 2003, ISBN: 9780130618900
5.	Programmable Logic Controller	Jadhav, V. R.	Khanna publishers, New Delhi, 2017, ISBN: 9788174092281
6.	Programmable Logic Controllers and Industrial Automation - An introduction,	Mitra, Madhuchandra; Sengupta, Samarjit,	Penram International Publication, 2015, ISBN: 9788187972174
7.	Control System	Nagrath & Gopal	New Age International Pvt Ltd, ISBN: 9789386070111, 9789386070111
8.	Linear Control Systems with MATLAB Applications, Publisher:	Manke, B. S.	Khanna Publishers, ISBN: 9788174093103, 9788174093103
9.	Supervisory Control and Data Acquisition	Boyar, S. A.	ISA Publication, USA, ISBN: 978-1936007097
10.	Practical SCADA for industry,	Bailey David ; Wright Edwin	Newnes (an imprint of Elsevier), UK 2003, ISBN:0750658053

(b) **Suggested Open Educational Resources (OER):**

1. Process Automation Control- online Tutorial: www.pacontrol.com
2. PLC product: www.seimens.com
3. www.ab.rockwellautomation.com
4. PLC product: www.abb.co.in
5. Different product of PLC and Peripherals, Smart Tile CPU Board, All in one lighting energy controller, Classic PLC www.triplc.com
6. Simulation software:http://plc-training-rslogix-simulator.soft32.com/free-download/
7. Simulator:www.plcsimulator.net/
8. https://www.youtube.com/watch?v=y2eWdLk0-Ho&list=PLln3BHg93SQ_X5rPjqP8gLLxQnNSMHuj-
9. https://www.youtube.com/watch?v=86CrhxgAKTw

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested OER, before use by the students.

(c) **Others: (If any)**

1. Learning Packages
2. Users' Guide
3. Manufacturers' Manual
4. Lab Manuals

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**

A) **Course Code** : **2000505G / 2000508G / 2000511G**

B) **Course Title** : **Electric Vehicle (Basic)**

C) **Prerequisite Course(s)** :

D) **Rationale** :

Fossil fuel consumption and its adverse impact on the environment have led most nations in the world to adopt electric vehicles for mobility. Most automobile companies are switching from internal combustion engines to electric, a cleaner, and more sustainable alternative. But, in the present scenario, the automobile industries are facing a shortage of skilled technicians needed for the transition to electric drives as the primary source of motive power. There is a huge skill gap between industry and academia when it comes to the task of taking the entire automobile industry towards electric mobility. Therefore, this basic course on an electric vehicles is included in the curriculum of the diploma programme as an open elective course to fill this gap and gain a basic understanding of the importance and necessity of electric vehicles. This course tends to enable participants with multidisciplinary exposure and give them a brief idea about electric vehicles, and their importance. This course gives some basic technical foundations regarding electric vehicles to help them move on to advanced electric vehicle courses.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of the following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the student will be able to-

CO-1 Classify the EVs based on configurations.

CO-2 Identify relevant Motors for the given EV application.

CO-3 Test the performance of batteries used for EV applications.

CO-4 Distinguish between the EV Charging stations based on their Configurations.

CO-5 Follow regulatory requirements and policies for EV Industry.

F) **Course Articulation Matrix:**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)(if any)		
	PO-1 Basic and Discipline-Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1 Classify the EVs based on configurations	3	2	-	2	2	-	3			
CO-2 Identify relevant Motors for the given EV application.	3	2	2	2	2	1	3			
CO-3 Test the performance of batteries used	2	2	3	3	2	2	3			

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)(if any)		
	PO-1 Basic and Discipline-Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
for EV applications										
CO-4 Distinguish between the EV Charging stations based on their configurations	2	2	1	2	2	1	2			
CO-5 Follow regulatory requirements and policies for EV Industry.	1	1	-	-	3	1	2			

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G)   Scheme of Studies:

CourseCode	Course Title	Scheme of Studies (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (SW+ SL)	Total Hours (CI+LI+SW+SL)	Total Credits(C)
		L	T				
2000505G / 2000508G / 2000511H	Electric Vehicles (Basic)	02	-	04	02	08	05

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 in the 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.

SW: Sessional Work/Term work (includes assignments, seminars, micro-projects, industrial visits, any other student activities, etc.)

SL: Self-Learning, MOOCs, Spoken Tutorials, Open Educational Resources (OERs)

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

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

H) Scheme of Assessment:

Course Code	Course Title	Scheme of Assessment (Marks)						Total Marks (TA+SWA+LA)
		Theory Assessment (TA)		Sessional Work Assessment (SWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Sessional Work Assessment (PSWA)	End Sessional Work Assessment (ESWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2000505G / 2000508G / 2000511G	Electric Vehicles (Basic)	30	70	20	30	20	30	200

Legend:
PTA: Progressive Theory Assessment in the classroom (includes class test, mid-term test and quiz using online/offline modes)
PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)
SWA: Sessional Work/Term work& Self-Learning Assessment (Includes assessment related to student performance in self-learning, assignments, Seminars, micro-projects, industrial visits, any other student activities etc.
Note: Separate passing is a must for progressive and end-semester assessment for both theory and practical.

I) Course Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at the course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional 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 the 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: [2000505G]

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)

TSO 1a. Identify the types of the vehicle based on the physical features, specification data and information.
TSO 1b. State the advantages of EVs over Conventional IC Engine Vehicles.
TSO 1c. Identify different components of Electric Vehicle systems
TSO 1d. Explain the functions of different components of the EV
	Unit-1.0 Introduction to Electric Vehicle
	Review of Conventional Vehicle Engine System
	Electric Vehicle (EV)
	• The necessity of Electric Vehicle
	• Types of Electric Vehicles
	  - Plug-in hybrid
	  - Battery electric vehicle
	  - Hybrid electric vehicle
	  - Fuel Cell Electric Vehicle
	• Advantages of Electric Vehicles
	Electric Vehicle Components: Motor, Motor Controller, Battery, Battery Management System, and Charging System.
		CO1

TSO 2a. Explain the general characteristics of motors used in EV TSO 2b. List different types of motors used in EV TSO 2c. Explain the working principles of motors used in	**Unit-2.0 Electric Motors used in EVs** Electric Motors for EV applications • General Characteristics of motors • Types of Motors: DC, Brushless DC,	CO2

Major Theory Session Outcomes (TSOs)		Units	Relevant COs Number(s)
	EV applications	Induction, Permanent Magnet Synchronous Motors, Switched Reluctance Motors	
TSO 2d.	Interpret the nameplate ratings of the motors for EV applications.		
TSO 2e.	Explain the motor selection criteria for particular EV applications.	Rating of Motors Selection Criteria Physical Location	
TSO 2f.	Describe the Mechanical and Electrical Connections of Motors.	Connection of Motors: Mechanical Connections and Electrical Connections	
TSO 3a.	List the batteries used in EVs for energy storage	**Unit- 3.0 EV Batteries and Energy Storages**	**CO3**
TSO 3b.	State various parameters related to batteries used in EV applications.	Types of Batteries: Lead Acid, Nickel Based, Lithium Based	
TSO 3c.	Explain the charging and discharging process of the given batteries.	Battery Parameters Charging (AC) and Discharging(DC) Process	
TSO 3d.	Explain the salient features of Lithium Ion batteries	Lithium Ion Batteries	
TSO 3e.	Explain the Fuel Cell Storage System.	Fuel Cells, Fuel Cell Storage System	
TSO 3f.	Identify various sensors installed for monitoring Battery condition.	Battery Condition Monitoring Battery Management System (BMS)	
TSO 3g.	Explain Battery Management System in EV using Block Diagram.	• Need of BMS • Block Diagram of BMS	
TSO 3h.	Describe the procedure of battery Disposal and Recycling	Battery Disposal and Recycling	
TSO 4a.	Identify different types of diodes and transistors.	**Unit- 4.0 EV Charging Systems** Power electronics in EV	**CO4**
TSO 4b.	Describe the testing procedure for the given Diode and Transistor.	• Power electronics components • Rectifiers	
TSO 4c.	Explain the working principles of the given power electronic converter circuit.	• DC to DC Converter • DC to AC Converter	
TSO 4d.	Describe the types of Charging Systems	Charging System	
TSO 4e.	Describe different Components of the Charging System	• Types of charging Systems • Components of Charging Systems	
TSO 4f.	Explain the working of the Charging System using a single-line diagram.	• Single line Diagram of Charging System	
TSO 5a.	Understand the Rules and Regulations set by the Government for selecting and manufacturing various components of an electric vehicle.	**Unit- 5.0 Regulatory Requirements and Policies for EV Industry** Rules and Regulations set by the Indian government for the designer/manufacturer of EVs.	**CO5**
TSO 5b.	Understand the Policies for E-Vehicles.	Policies in India	
TSO 5c.	Appreciate the importance of the reduction of greenhouse gases in the environment.	Global Policies for E- Vehicles. Carbon Footprint Issues	

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

K)   Laboratory (Practical) Session Outcomes (LSOs) and List of Practical [2000508G]

Practical/Lab Session Outcomes (LSOs)		S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 2.1	Use the relevant digital meter for the given application.	1.	• Practice using digital meters such as AC, DC Clamp Meters, Digital Multimeters, Lux Meters, etc.	CO1
LSO 2.2	Use a measuring instrument for the given application.		• Practice using Screw Driver Kit, Vernier	
LSO 2.3	Use safety kits while working in the			

Practical/Lab Session Outcomes (LSOs)		S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
	laboratory.		Caliper, Micrometer, Ampere Meter, Voltage Meter, and Techno-meter. • Practice using safety kits.	
LSO 2.1	Identify the motors used in EV applications	2.	• Identification of motors used in EVs	CO2
LSO 2.2	Identify the given motor terminals			
LSO 3.1	Identify the batteries available in the laboratory.	3.	• Testing of Batteries used in EVs	CO3
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.		• Battery Management System	
LSO 4.1	Identify the Electrical & Electronics components available in the laboratory using Digital Multimeters.	4.	• Power electronic circuits	CO4
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		• Identification of Charging systems	
LSO 4.5	Recognize the types of Charging Systems available in the Laboratory			

L) **Sessional Work and Self-Learning: [2000511G]**

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

  b. Micro Projects:

     1. Collect the information related to the performance of different types of electric vehicles and prepare a comparative report on economic and environmental analysis.
     2. Collect specifications of different EVs available in the market.
     3. Build and test a prototype circuit of converters used in an electric vehicle.
     4. Visit a nearby Electric vehicle showroom or service centre & collect information on different types of motors used in electric vehicles and prepare a comparative report on their performance,
     5. Visit a nearby charging station and prepare a report describing the layout and components of the charging station.

c.Other Activities:

    1. Seminar Topics:
       • Communication Systems, Sensors and batteries used in Evs.
       • Technological advances in Evs
       • Comparison of EVs manufactured by different companies.
    2. Surveys – Survey the market and gather information on the electric vehicle manufacturers and submit the report.
    3. Product Development- Develop an electric vehicle prototype using locally procured hardware components.

d. **Self-learning topics:**
       • Global Manufacturers of EV

- Indian Manufacturers of EV

- Motors used in EV
- Batteries used in EV
- Cost comparison of EVs in market

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

COs	Theory Assessment (TA)**		Sessional Work Assessment (SWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Sessional Work & Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	10%	10%	20%	--	33%	10%	20%
CO-2	15%	10%	20%	--	33%	15%	20%
CO-3	15%	30%	20%	--	34%	15%	20%
CO-4	30%	30%	20%	50%	--	30%	20%
CO-5	30%	20%	20%	50%	--	30%	20%
Total Marks	30	70	20	20	10	20	30
			50				

Legend:
*: Other Activities include seminars, visits, surveys, product development, software development etc.
**: Mentioned under
point#: Mentioned under
point
Note: For CO attainment calculation, Indirect assessment tools like Course exit survey need to be used which comprises of questions related to achievement of each COs.

N) **Specification Table for End Semester Theory Assessment:** The course teacher has to decide and use the appropriate assessment strategy and its weightage, in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be assessed to calculate CO attainment.

Unit Title and Number	Relevant COs Number(s)	Total Marks	ETA (Marks)		
			Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Introduction to Electric Vehicle	**CO1**	12	3	5	4
Unit-2.0 Electric Motors used in EVs.	**CO2**	15	4	6	5
Unit- 3.0 EV Batteries and Energy Storages.	**CO3**	20	5	9	5
Unit- 4.0 EV Charging Systems	**CO4**	15	5	6	4
Unit- 5.0 Regulatory Requirements and Policies for EV Industry	**CO5**	8	3	3	3
Total Marks		**70**	**20**	**29**	**21**

Note: Similar table can also be used to design class/mid-term/ internal question papers for progressive assessment.

O) Specification Table for Laboratory (Practical) Assessment:

S. N.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA Performance PRA (%)	PDA (%)	Viva-Voce (%)
1	Practice using digital meters such as AC, DC Clamp Meters, Digital Multimeters, Lux Meters, etc.	CO1	30	-	20
2	Practice using Screw Driver Kit, Vernier Caliper, Micrometer, Ampere Meter, Voltage Meter, and Techno-meter.				
3	Practice using safety kits.				
4	Identification of motors used in EV	CO2	15	40	30
5	Testing of Batteries used in EVs	CO3	15	40	30
6	Battery Management System	CO3			
7	Power electronic circuits	CO4	40	20	20
8	Identification of Charging systems	CO4			

Note: This table can be used for both the end semester as well as progressive assessment of practicals. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student's performance.

P) Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Labs, and Field, Information and Communications Technology (ICT)Based, Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	AC, DC Clamp Meters	Application: Non-contact AC/DC Voltage and Current measurement **AC Application:** Current: 0-200Amp, Voltage: 0-600Volt **DC Application:** Current: 4-20mA, Voltage: 0-30Volt.	1
2.	Digital Multimeters	Display: 4 ½ digit Indications: overload protection, polarity indication, over range indication. Auto range change and auto polarity change facility, auto display of polarity and decimal point. **DC**: Volt: 200mV-600V, Current: 200mA-2A **AC**: Volt: 200mV-1000V, Current: 200mA-2A Resistance: 200W-20mW, Power supply: 230V, 50Hz Battery operation: 9 Volt battery Electronic components testing facility should be provided in the Multimeter. A provision for an A.C. adaptor(eliminator) must be available along with the multimeter.	1, 3
3.	Lux Meters	Functions: MAX / MIN, Backlight, Auto Power Off Range: 0 ~ 200,000 lux 0 ~ 20,000 fc Accuracy: ± 5% rdg + 10 dgt (< 10.000 lux / fc) ± 10% rdg +	1

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
		10 dgt (>10.000 lux / fc) Resolution: 0.1 lux or 0.1 fc Accessories: Carrying Case, Installation Manual, 9V Battery (installed).	
4.	Screw Driver toolbox	All types of screw drive sets.	1
5.	Vernier Caliper	**Range:** Lower scale: 0-200mm, Upper Scale: 0-12inch **Vernier Resolution:** Lower Scale: 0.02mm, Upper Scale: 0.001inch	1
6.	Micrometer	0-25mm (inside/outside)	1
7.	Ampere Meter	Moving iron and Moving Coil	1
8.	Voltmeter	AC(0-250V)/DC(0-24V)	1
9.	Tachometer	For speed measurement (0-3000rpm)	1
10.	Resistors	Low-value Resistors of different types	1,4
11.	Capacitors	Low-value electrolyte Capacitors.	1,4
12.	Inductors	Low-value inductors.	1,4
13.	Safety Kit	First Aid Kit, Helmet, Face Mask, Gloves etc.	1
14.	Motors for Electric Vehicle application	Brushless DC, Induction, Permanent Magnet Synchronous Motors, Switched Reluctance Motors	2
15.	EV Machine Cut-out section	for demonstration & training	2
16.	EV mock layout	for demonstration & training	2
17.	Lithium Ion Battery	12V, 7Ah	3
18.	Lead-acid battery	12V, 7Ah	3
19.	Nickel-based batteries (metal hydride and cadmium battery).	12V, 7Ah	3
20.	Battery internal resistance meter	For O.C. voltage & internal battery resistance of each cell	3
21.	Cell Capacity tester	Up to 15V batteries and 3A load current, 10mV voltage and 1mA current resolution, Automatic detection of termination voltage, LED display with a 3-button interface.	3
22.	BMS setup	For Demonstration & training	3
23.	DC power supply	0-32V	3
24.	Power diodes	Power diodes of different current values.	1, 4
25.	Transistors	Power Transistors (NPN, PNP) for Low-frequency high-power applications.	1,4
26.	Voltage Sensors	0-12 Volts.	1,3,4

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
27.	Current Sensors	Volts: + 15v, 0-5v, Current: 4-20mA.	1,3,4
28.	Converter Models	DC to DC and DA to AC converter model	4
29.	Charging Station Simulator	For Demonstration & training purposes.	4
30.	EV Technology layout 3D poster with frame	Fuel cell, EV- Charging Systems, HEV, FCEV, Motors & Controllers etc.	3,4

R)   **Suggested Learning Resources:**

     (a)   **Suggested Books** :

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Handbook on Electric Vehicles Manufacturing (E-Car, Electric Bicycle, E- Scooter, E-Motorcycle, Electric Rickshaw, E- Bus, Electric Truck with Assembly Process, Machinery Equipments & Layout)	P.K. Tripathi	Niir Project Consultancy Services; 1st edition (1 January 2022) ISBN-13 : 978-8195676927
2.	Electric Vehicles: And the End of the ICE age	Anupam Singh	Kindle Edition ASIN : B07R3WFR28
3.	Wireless Power Transfer Technologies for Electric Vehicles (Key Technologies on New Energy Vehicles)	Xi Zhang, Chong Zhu, Haitao Song	Springer Verlag, Singapore; 1st ed. 2022 edition (23 January 2022) ISBN-13 : 978-9811683473
4.	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles	EHSANI	CRC Press; Third edition (1 January 2019)ISBN-13 : 978-0367137465
5.	Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles	John G. Hayes, G. Abas Goodarzi	Wiley; 1st edition (26 January 2018) ISBN-13 : 978-1119063643
6.	New Perspectives on Electric Vehicles	Marian Găiceanu (Editor)	IntechOpen (30 March 2022) ISBN-13 : 978-1839696145

     (b)   **Suggested Open Educational Resources (OER):**

         1.   https://www.energy.gov/eere/fuelcells/fuel-cell-systems
         2.   https://powermin.gov.in/en/content/electric-vehicle
         3.   https://www.iea.org/reports/electric-vehicles
         4.   https://www.oercommons.org/search?f.search=Electric+Vehicles

Note: Teachers are requested to check the creative commons licence status/ financial implications of the suggested OER, before use by the students.

     (c)   **Others: (If any)**

         1.   Learning Packages
         2.   Users' Guide
         3.   Manufacturers' Manual
         4.   Lab Manuals

A)	Course Code	: 2000505 H / 2000508 H / 2000511H
B)	**Course Title**	: **Robotics (Basics)**
C)	**Pre- requisite Course(s)**	:
D)	**Rationale**	:

Currently, industries demand non-stop and fine quality work in different processes used. It is difficult for the human beings to give same quantity and quality of work with respect to time, environment and complexity of the work in any process industry. To get quality and quantity of work in toughest environment or the environment which is not suitable for the humans to work, industries demand for robots and its operator. Operators who will operate these robots need some basic knowledge of robotics. To fulfill the need of industries and looking to the advancement in technology, this course aims for the diploma engineers to have knowledge and skills in robotics.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

Select robots for given applications employing basic concepts of design and functions of robots.

Interpret co-ordinate systems and degree of freedom for robots.

Use sensors and drives in context of various robotic applications.

Select appropriate robot control techniques,

Use programs to operate robots.

F) **Course Articulation Matrix:**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs) (if any)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1	3	-	3	-	2	2	2			
	3	2	1	2	-	-	-			
CO-2	3	2	1	2	2	-	2			
CO-3	3	1	1	2	-	-	-			
CO-4	3	2	3	3	2	3	2			

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G) **Scheme of Studies:**

Course Code	Course Title	Scheme of Studies (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (SW+ SL)	Total Hours (CI+LI+SW+SL)	Total Credits(C)
		L	T				
2000505H/ 2000508H/ 2000511H	Robotics (Basics)	02	-	04	02	08	05

Legend:
CI:

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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)

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LI : Laboratory Instruction (Includes experiments/practical performances 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.

SW: Sessional Work/Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, open educational resources (OERs)

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

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

H)   Scheme of Assessment:

Course Code	Course Title	Scheme of Assessment (Marks)						Total Marks (TA+SWA+LA)
		Theory Assessment (TA)		Sessional Work Assessment (SWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Sessional Work Assessment (PSWA)	End Sessional Work Assessment (ESWA)	Progressive Lab Assessment(PLA)	End Laboratory Assessment (ELA)	
2000505H / 2000508H / 2000511H	Robotics (Basics)	30	70	**20**	**30**	20	30	200

Legend:

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

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

SWA: Sessional Work/Term work & Self Learning Assessment (Includes assessment related to student performance in self learning, assignments, Seminars, micro projects, industrial visits, any other student activities etc.

Note: Separate passing is must for progressive and end semester assessment for both theory and practical.

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), Sessional 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: [2000505H]

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.	**Unit-1.0 Basics of Robotics Systems** 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; Mechanic alarm, 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	CO1,CO2

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Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 2a. Explain the working of various types of End effecters used in robots with diagram. TSO 2b. Explain with sketches the function of thegiven 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 ofrobot vision system. TSO 2g. Select vision equipment for a givenrobotic application.	**Unit– 2.0 Robot Components** 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 – straingauge, 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	CO3
TSO 3a. Explain with sketches the function of the specified actuator used in a robot. TSO 3b. Differentiate between open loopand 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 forrobotic control as per requirement. TSO 3f. Differentiate the various robot pathcontrols. TSO 3g. Justify the selection of actuators, drives, control system, AC servo motor and path control for makingof a robot.	**Unit– 3.0 Robotic Drive System and Controller** 3.1 Actuators; Hydraulic, Pneumatic and Electrical drives; linear actuator; Rotarydrives 3.2 Control systems : Open loop and close loopwith applications and its elements, Servo and non-servo control systems – Types, basic principles and block diagram Robot controller; Level of Controller 3.3 AC servo motor; DC servo motors andStepper motors; 3.4 Robot path control: Point to point, Continuous path control and Sensor basedpath control	CO4
TSO 4a. Explain various robot programming languages. TSO 4b. Programme robot for a given simplejob. TSO 4c. Describe the procedure to simulate the given robot movements using the relevant software.	**Unit– 4.0 Introduction to Robot Programming** 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 movements	CO5
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.	**Unit– 5.0 Robotics Applications and Maintenance aspects** 5.1 Application robots including specialtypes 5.2 Robot maintenance: Need and types 5.3 Common troubles and remedies inrobot operation. 5.4 General safety norms, aspects and precautions in robot handling	CO1,CO2, CO3,CO4

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Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)

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

K) Laboratory (Practical) Session Outcomes (LSOs) and List of Practical [2000508H]

Practical/Lab Session Outcomes(LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSOs 1.1 Identify parts of Robot on the basis of function. 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
LSOs 2.1 Identify different types of robot end effecters. 2.2 Use Mechanical grippers to hold objects. 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 3.2 Apply the functionalities available in rotor trainer kit. 3.3 Test for various configurations. 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
LSOs 4.1 Identify various types of sensors used in robotic application. 4.2 Measure angular motion using Synchros. 4.3 Detect objects using optical sensors.	4.	Use different types of robotic sensors for a specific situation.	CO3
LSOs 5.1 Interface stepper motor. 5.2 Control robot with stepper motor interfacing.	5.	Perform robot control with stepper motor interfacing	CO3
LSOs 6.1 Draw the labelled sketch of individual parts and robot arm. 6.2 Assemble the arm using the parts as per the procedure. 6.3 Interface the motor drive and operate.	6.	Assemble robot arms using mechanical transmission components and interface motor drive.	CO2, CO3
LSOs 7.1 Use open source or available relevant software to develop pick and place programme. 7.2 Perform simulation.	7.	Perform pick and place operation using Simulation Control Software.	CO5
LSOs 8.1 Develop programme for using a robot arm with three degrees of freedom. 8.2 Execute the programme.	8.	Perform 2D simulation of a 3 DOF robot arm.	CO2, CO4, CO5

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Practical/Lab Session Outcomes(LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSOs 9.1 Apply stepper motor control with direction control and step control logic simulation. 9.2 Perform basic PLC programming 9.3 Develop ladder logic programs 9.4 Use programming timers	9.	Programme 5-axis Robotic arm to control various motions.	CO3, CO4, CO5
LSOs 10.1 Develop a program for a simple application. 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) **Sessional Work and Self Learning: [2000511H]**

    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

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

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Sessional Work Assessment (SWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Sessional Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	20%	20%	20%	10%	25%	10%	20%
CO-2	20 %	25%	20%	10%	25%	20%	20%
CO-3	25%	25%	20%	25%	25%	20%	20%
CO-4	20%	20%	20%	15%	25%	20%	20%
CO-5	15%	10%	20%	40%	--	30%	20%
Total	30	70	20	20	10	20	30
Marks				50			

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Legend:

* **:** Other Activities include self learning, seminar, visits, surveys, product development, software development etc.
** ** ** : Mentioned under point- (N)
# : Mentioned under point-(O)

Note: For CO attainment calculation, Indirect assessment tools like Course exit survey need to be used which comprises of questions related to achievement of each COs.

N) **Specification Table for End Semester Theory Assessment:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be assessed to calculate CO attainment.

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Unit Number and Title	Relevant COs Number(s)	Total Marks	ETA (Marks)		
			Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Basics of Robotics Systems	CO1,CO2	20	7	7	5
Unit– 2.0 Robot Components	CO2,CO3	16	3	8	5
Unit– 3.0 Robotic Drive System and Controller	CO3,CO4	12	4	4	5
Unit– 4.0 Introduction to Robot Programming	CO5	10	2	4	4
Unit– 5.0 Robotics Applications and Maintenance aspects	CO1,CO2, CO3,CO4	12	4	4	4
	Total Marks	70	20	27	23

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O)   Specification Table for Laboratory (Practical) Assessment:

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA (%)	PDA (%)	
1.	Identify components and different configurations of robots.	CO1	30	50	20
2.	Pick/hold different objects (shape/weight/stiffness) using robot end effecters.	CO1, CO2	60	30	10
3.	Assemble robot to test various configurations and degrees of freedom using robot trainer kit.	CO1, CO2	70	20	10
4.	Use different types of robotic sensors for a specific situation.	CO3	60	30	10
5.	Perform robot control with stepper motor interfacing	CO3	70	20	10
6.	Assemble robot arms using mechanical transmission components and interface motor drive.	CO2, CO3	60	30	10
7.	Perform pick and place operation using Simulation Control Software.	CO5	70	20	10
8.	Perform 2D simulation of a 3 DOF robot arm.	CO2, CO4, CO5	60	30	10
9.	Programme 5-axis Robotic arm to control various motions.	CO3, CO4, CO5	60	30	10
10.	Program to execute a simple robot application (like painting, straight welding) using a given configuration.	CO4, CO5	60	30	10

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P)   Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology

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(ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources(OER), MOOCs etc.

Q)   List of Major Laboratory Equipment, Tools and Software:

S.No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Programmable Robot trainer kit	Trainer kit with - Minimum 3 linkages, Minimum 4degree of freedom, Mechanical end effecter withservo control, interfacing card (RC servo output, sensors input)	1,2,3
2.	Robotic Arm Control Trainer Kit	botic Arm with five axis control application through PLC.; PLC; Digital Inputs: 8 Nos with 4mmbanana sockets for getting the external inputs; Digital Outputs: 6 Nos with 4mm banana sockets for applying the inputs; Digital Input Controls: Onboard Toggle switches, Push Buttons & input potentiometers; Digital Outputs Controls: 6 nos. on board LED indicators; PC interfacing facility through RS-232.	8,9
3.	Proximity trainer kit	Indicator Type:LED; PCB Type Glass EpoxySMOBC PCB; Interconnections**:** 2mm banana Patch cords; On board DC motor to see the application of Proximity sensor. Test points to analyse the signal On board variable supply to vary the speed of DC motor. ON/OFF switch and LED for power indication. All interconnections to be made using 2mm banana Patch cords. User manual and patch cords. Built-in power supply. Robust enclosure wooden/plastic box.	4
4.	Robot - Line Tracking Mouse Kit	Product Dimensions (20.3 x 11.4 x 8.9 cm); programmed IC, 2 unassembled gear motors, printed circuit boards, mouse-shaped plasticbody, necessary components and wires, step- down power converter	3, 4,5
5.	Intelligent Robot Actuator Module	Integrity Serial Bus System, CAN to Build Intelligent Device Network, Open Hardware Platform, Arduino, to control Robot sub-Systems of motor-sensor, movable Omni Wheel of Omni- Directional, Actuator operation control by DC Encoder Motor, DC-Motor control and operation by Accelerometer, Gyro, Ultrasonic and PSD sensor, Androx Studio; brushless ILM 70×10 RoboDrive DC motor; sensor-actuator units of ARMAR-4; SD-25-160-2A-GR-BB Harmonic Drive reduction gear unit high gear ratio of 160: 1;structural parts (white) are made out of high- strength aluminium, Hollow shaft with strain gauges for torque sensing, motor's magnetic incremental encoder (AMS5306), digital buses (SPI or 12C); Motor interface PCB includes a 13- Bit temperature-to-digital converter with a temperature range from −40°C to 125°C (Analog Devices ADT7302)	3, 4, 5
6.	6-axis Robotics Trainer	Programmable robotic arm with an interactive front panel. Software to demonstrates functioning of the trainer as well as allows a user	3, 4, 5

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S.No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/ Practical Number
		to develop their own programs. NV330; 8 bit microcontroller to ARM processors; Record and Play capability; Optional interfacing with PLC; Touch operated ON/OFF switch; Auto set to home position; Applications can be developed; Data acquisition using USB	
7.	Robotic Drive System	AC servo motor; DC servo motors, Stepper motors; DC tachometers, etc.	1,3,5,6,7,10
8.	Robot simulator for Robotics	Educational networking licensed Robotic system with simulation software	8, 10
9.	Assorted sensors	Optical encoders, Acoustic sensors ,IR, Potentiometer, RTD, Thermistor, strain gauge, piezoelectric, etc	4
10.	Vision equipment	Camera, Imaging Components: Point, Line, Planar and Volume Sensors	1, 4,10

R)   Suggested Learning Resources:

    (a)   Suggested Books :

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Introduction to Robotics Mechanics and Control	John Craig	Pearson Education ; 978-9356062191
2.	Industrial Robotics -Technology, Programming and Applications	Nicholas Odrey Mitchell Weiss, Mikell Groover Roger Nagel, Ashish Dutta	McGraw Hill Education; 2nd Edition; 978 -1259006210
3.	Robotic engineering : an integrated approach	Richard D. Klafter, Thomas A. Thomas A. Chmielewski, Michael Negin	Prentice Hall of India, N.Delhi , 978-8120308428
4.	Industrial Robotics Technology, Programming and Applications	Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey	McGraw-Hill Education , Second Edition, 978-1259006210
5.	Robotics	Appuu Kuttan K. K.	Dreamtech Press, First Edition, 2020, 978-9389583281
6.	Introduction to Robotics: Analysis, Control, Applications	Saeed B.Niku	Wiley; Second Edition, 978-8126533121
7.	Essentials of Robotics Process Automation	S. Muhkerjee	Khanna Publication, First edition, 978-9386173751
8.	Robotics	R R Ghorpade , M M Bhoomkar	Nirali Prakashan 978-9388897020

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(b)   Suggested Open Educational Resources (OER):

1. https://archive.nptel.ac.in/courses/112/105/112105249/
2. https://openlearning.mit.edu/mit-faculty/residential-digital-innovations/task-centered-learning-intro-eecs-robotics
3. http://www.mtabindia.com/
4. http://www.robotics.org/
5. https://en.wikipedia.org/wiki/Industrial_robot
6. http://www.servodatabase.com

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7. https://www.youtube.com/watch?v=fH4VwTgfyrQ
8. https://www.youtube.com/watch?v=aW_BM_S0z4k
9. https://uk.rs-online.com/web/generalDisplay.html?id=ideas-and-advice/robotic-parts-guide
10. https://www.automate.org/industry-insights/smarter-robot-grasping-with-sensors-software- the-cloud
11. https://www.iqsdirectory.com/articles/machine-vision-system.html

Note: Teachers are requested to check the creative commons licence status/ financial implications of thesuggested OER, before use by the students.

(c) Others: (If any)

1. Learning Packages
   - https://www.edx.org/learn/robotics
   - https://www.coursera.org/courses?query=robotics
   - https://www.udemy.com/topic/robotics/
   - https://library.e.abb.com/public/9a0dacfdec8aa03dc12578ca003bfd2a/Learn%20with%20ABB.%20 Robotic%20package%20for%20education.pdf

2. Users' Guide
   - https://roboindia.com/store/DIY-do-it-your-self-educational-kits-robotics-embedded-system- electronics
   - https://www.robomart.com/diy-robotic-kits
   - https://www.scientechworld.com/robotics

3. Lab Manuals
   - http://www-cvr.ai.uiuc.edu/Teaching/ece470/docs/ROS_LabManual.pdf
   - https://www.jnec.org/labmanuals/mech/be/sem1/Final%20Year%20B.Tech-ROBOTICS%20LAB%20%20MANUAL.pdf

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MICROCONTROLLER LAB

Subject Code 2043506	Practical						Credits
	No. of Periods Per Week			Full Marks	:	50	03
	L	T	P/S	Internal (PA)	:	15	
	--	—	06	External (ESE)	:	35	

List of Experiments

1. Write an Assembly Language Programme for Multi-byte Addition and execute the same in the 8051 Kit.

2. Write an Assembly Language Programme for Multiplication and Division of two numbers and execute the same in the 8051 Kit.

3. Write an Assembly Language Programme for arranging the given data in ascending order and execute the same in the 8051 Kit.

4. Write an Assembly Language Programme for BCD to Hex conversion and execute the same in the 8051 Kit.

5. Write an Assembly Language Programme for Hex to BCD conversion and execute the same in the 8051 Kit.

6. Write an Assembly Language Programme for ASCII to Binary and execute the same in the 8051 Kit.

7. Write an Assembly Language Programme for Parity bit generation and execute the same in the 8051 Kit.

8. Write an Assembly Language Programme for using timer / Counter and execute the same in the 8051 Kit.

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PROGRAMMING IN C LAB

Subject Code 2043508A	Practical			No of Period in one session :			Credits
	No. of Periods Per Week			Full Marks	:	50	03
	L	T	P/S	Internal (PA)	:	20	
	--	—	04	External (ESE)	:	30	

Course Learning Objectives:

This Lab course is intended to practice what is taught in theory class of 'Computer Programming' and become proficient in computer programming. Computer programming is all about regular practice. Students should work on solved and unsolved problems listed in the text books, and the problems given by the teacher. Some of the topics that should necessary be covered in lab are listed below.

Course outcomes:

Student should be able to write code snippets, and then compile, debug and execute them.

	Content: Practical	Hrs.
Unit – 1	Familiarization with programming environment (Editor, Compiler, etc.)	04
Unit – 2	Programs using, I/O statements and various operators	04
Unit – 3	Programs using expression evaluation and precedence	04
Unit – 4	Programs using decision making statements and branching statements	04
Unit – 5	Programs using loop statements	04
Unit – 6	Programs to demonstrate applications of n dimensional arrays	04
Unit – 7	Programs to demonstrate use of string manipulation functions	04
Unit – 8	Programs to demonstrate parameter passing mechanism	04
Unit – 9	Programs to demonstrate recursion	04
Unit – 10	Programs to demonstrate use of pointers	04
Unit – 11	Programs to demonstrate command line arguments	03
Unit – 12	Programs to demonstrate dynamic memory allocation	03

The language of choice will be C. This is a skill course. More you practice, better it will be.

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Reference Books:

1. Let Us C, Yash Avant Kanetkar

2. Problem Solving and Programming in C, R.S. Salaria, Khanna Publishing House

3. C Programming Absolute Beginner's Guide, Dean Miller and Greg Perry

4. The C Programming Language, Kernighan and Ritchie, Prentice Hall of India

5. Programming in ANSI C, E. Balagurusamy, Tata McGraw-Hill

6. C Programming & Data Structures, B. A. Fouruzan and R. F. Gilberg, CENGAGE Learning.

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INPLANT TRAINING AND VISIT TO WORKS

Subject Code 2043509	Term Work			No of Period in one session :			Credits
	No. of Periods Per Week			Full Marks	:	100	
	L	T	P/S	Internal	:	30	
	—	—	4 Weeks Continuous	External	:	70	03

Course Objective:

ln plant training is a learning opportunity for students. Students should therefore receive feedback on their performance so that they can grow professionally. Over all professional development of diploma Robotics engineers is the need of the day for enabling them to sustain in competitive global environment.

COURSE OUTCOME:

CO 1 : Exposure to the organizational environment and recognize the requirement of the organization and cope with the organizational scenario.

CO 2 : Identify career paths taking into account their individual strengths and aptitude and prepare a report about the work experience in organization.

CO 3 : Communicate effectively through technical presentation.

CO 4 : Enhancing the employability skills and staft-up skills to increase his/her ability to engage in life- long learning.

CO 5 : Develop individual confidence to handle various engineering assignments and expose themselves to acquire life skills to meet societal challenges.

GUIDELINE FOR VISIT

- ln plant training means a course of training in any organization or establishment undergone by the student of final year diploma in Robotics Engineering in pursuance of memorandum of understanding between organization and department of the concerned institute or department can make necessary arrangements in the local vicinity industries to get on job learning exposure to the students in industries.

- Organization means any organization or business in which any trade, occupation or subject field in concerned engineering or technology. The Industries where Internship can be undergone: The supervisory faculty / Head of section / students may identify Robotics or Automation- based service / industrial organization preferably in the local vicinity with prior approval on the principal of concerned institution.

- Structured training to be detailed by the concerned supervisory faculty and a detailed report of the training undergone shall be submitted by the student for evaluation. The students may be allowed to undergo Internship in any Government/Private organizations dealing Robotics/Automation/Electronics/ based job or services.

- Obligation 0f students: Students must be punctual and exhibit good conduct during the training period. Students shall maintain log of activities and submit report on schedule of work entrusted during Internship. Students are required undergo Internship in stipulated time frame. Students are obligated to get familiar with the process and activities during in-plant training.

- Students may be encouraged to develop a solution to the tasks/problems related to the Electronic components testing/ servicing to acquire knowledge and to reciprocate to the industrial needs. Monitoring of Internship:

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- The Head of section shall prepare batches of students and allocate a supervisory faculty to each batch. Supervisory faculty shall assist students in identifying industrial organization and monitor the activities of the students during the schedule of training.
- The concerned supervisory faculty in consultation with respective industrial organization shall review the progress of students undergoing Internship in a time frame. The head of section must take complete responsibilities in organizing Internship. Student undergoing Internship in the respective branch of Engineering in any establishment shall be treated as a trainee.

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NPTEL / MOOCS/others (TW)

Subject Code 2043511	Practical			No of Period in one session :			Credits
	No. of Periods Per Week			Full Marks	:	50	01
	L	T	P/S	Internal (PA)	:	20	
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