Jharkhand University of Technology
Ranchi, 834010

TENTATIVE SYLLABUS

For Diploma Program in
Electrical Engineering/ Electrical & Electronics Engg.

(Effective from 2025-26)

DEPARTMENT OF ELECTRICAL ENGINEERING/ EEE

(5th – SEMESTER)

INDUSTRIAL AUTOMATION

Course Code- L:T:P

Introduction:

Automation in the industrial workplace provides the advantages of improving productivity and quality while reducing errors and waste, increasing safety, and adding flexibility to the manufacturing process. In the end, industrial automation yields increased safety, reliability, and profitability. This specialization course is taught in Boot camp mode. Boot camp are 12 weeks, intense learning sessions designed to prepare the students for the practical world – ready for either industry or becoming an entrepreneur. Student will be assisted through the course, with development-based assessments to enable progressive learning. Industrial automation course introduces Programmable Logic Controllers (PLC), Field level Instrumentation and SCADA/HMI Systems used for Industrial Automation. The students will get appropriate knowledge and exposure to configuration of Industrial Controllers and development of application programs. Also covers Interfacing with SCADA/HMI systems used for remote monitoring & control of industrial process units and machines.

Leading to the successful completion of this boot camp, students shall be equipped to either do an internship in an organization working on Automation and Robotics or do a capstone project in the related field. After the completion of Diploma, student shall be ready to take up roles like a Programmer, Supervisor and can rise up to the level of Manager, also can become Entrepreneur in the related field and more.

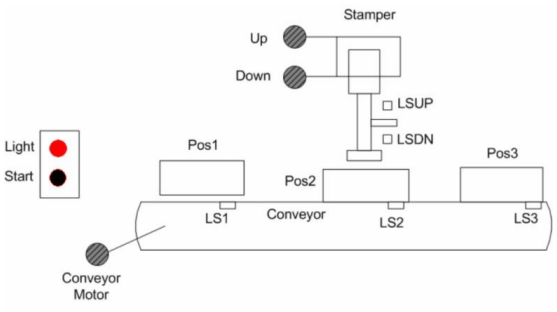
Course outcome:

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

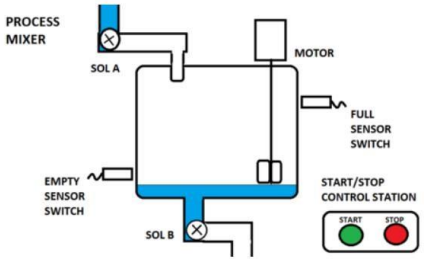
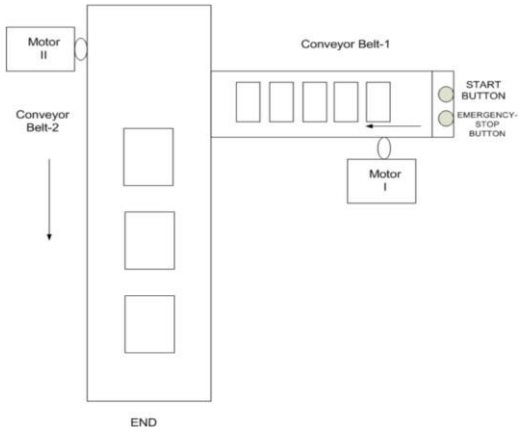
CO1	**Develop and test the PLC program for a given industrial application using simulation software.**
CO2	**Install, troubleshoot and maintain the PLC.**
CO3	**Interface VFD/servo motor with HMI and PLC to control various motor parameters.**
CO4	**Automate the given process and troubleshoot the system for its defects**.
CO5	**Interface SCADA /HMI with PLC and Control PLC from SCADA.**

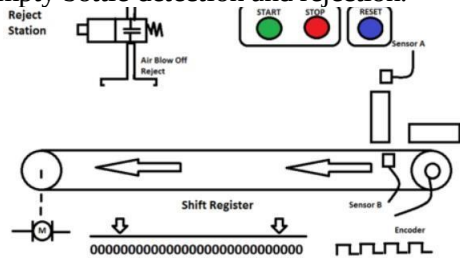
Detailed Course Plan

Week	C O	P O	Days	1st session (9 am to 1 pm)	L	T	P	2ND session (1.30 pm to4.30 pm)	L	T	P
1	1	3	1	**Introduction to industrial automation:** Video on automation • Why automation is required? • Examples to understand industrial automation • Motivation for Industrial Automation • Levels of Industrial Automation Process • Types of automation. • What can be automated and what cannot be automated?	3		1	• Introduction to process automation • Familiarizing with process control system Video demonstration: • Demonstrate the various automation processes.	1		2
	1	3	2	• Familiarizing and learning open loop and close loop systems with examples. • Demonstrate a closed-loop feedback system with a different applications • Demonstrate the different components used in process control. • Demonstrate how the process control system works.	2		2	Video Demonstration on • Automation of the beverage industry • Automation of motor stator production. • Automation of Transformer core • The Role of PLCs in manufacturing • PLC application stories			3

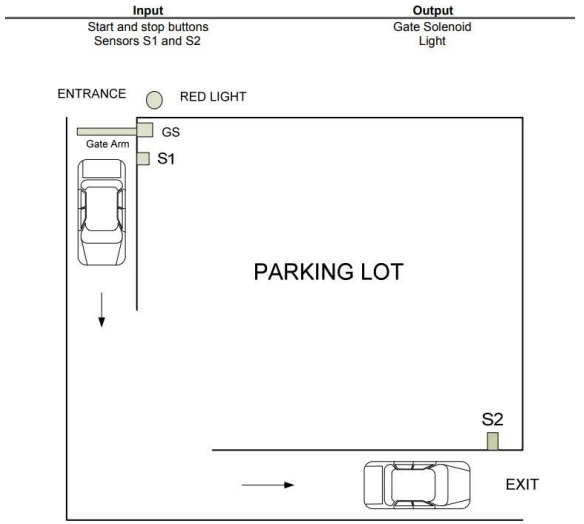
	1	2,3,4	3	**Advance PLC instructions** Bit Logic Instructions: Standard Contacts, Immediate Contacts, NOT Instruction, Positive and Negative Transition Instructions, Output, Output Immediate, Set and Reset, Set Immediate and Reset Immediate • Normally Open	2		2	**Develop a LAD (Ladder diagram) to control the stamp system.** **Identify and select sensors, switches and actuators required to implement the system.** An automatic stamp system shown in Figure 2 works as follows: When start switch is turned on, system gets ready to run. When the operator puts a box at the beginning of the conveyor (on LS1) the motor runs and conveyor moves. Upon			3
				• Normally Close • NOT logic • Coil • Set Coil • Reset Coil • Negative Edge • Positive Edge Demonstration of instructions Explain the five steps to PLC Program development • Define the task. • Define the inputs and outputs. • Develop a logical sequence of operation. • Develop the PLC program. • Test the program.				reaching the midpoint of the conveyor (on LS2) the conveyor motor stops. Then the stamp comes down and puts the stamp on the box. When this process is finished, the stamp goes up and conveyor moves again to the other end of the conveyor. After box reaches to end of the conveyor (on LS3), the motor stops. The system waits for the box to get and the box to be placed at the beginning of the conveyor. If start switch is turned off, the system cannot run even if there is a box on conveyor. The light on the start box indicates that the system is active whereas UP and Down lights indicate that the stamp is UP and DOWN position respectively.  			

	1	2,3,4	4	• To study the operation of different types of timers. • Timer Instructions: On-Delay Timer, Retentive On-Delay Timer, Off-Delay Timer • Counters: Count Up Counter, Count Down Counter, Count Up/Down Counter **Develop and Test a LAD (Ladder diagram)/ Functional Block Diagram(FBD) using simulation software, for the process mixer.**	2		2	**Develop and Test a LAD (Ladder diagram)/ Functional Block Diagram (FBD) for the given system using simulation software.** **Identify and select sensors ,switches and actuators required to implement the sytem.** The system to be controlled by PLC consists of two belts. If the Start button is pressed, Conveyor Belt-1 will begin to run. After 5 seconds Conveyor Belt-2 will be active. After the whole system runs			3

				Identify and select sensors, switches and actuators required to implement the sytem. A normally open start and normally closed stop pushbuttons are used to start and stop the process. When the start button is pressed, solenoid A energizes to start filling the tank. As the tank fills, the empty level sensor switch closes. When the tank is full, the full-level sensor switch closes. Solenoid A is de-energized. The mixer motor starts and runs for 3 minutes to mix the liquid. When the agitate motor stops, solenoid B is energized to empty the tank. When the tank is completely empty, the empty sensor switch opens to de-energize solenoid B. The start button is pressed to repeat the sequence.  				For 15 seconds, Conveyor Belt-1 will stop. Then Conveyor Belt-2 continues to move for 5 seconds And then it will stop, too. Also the system can be reset by the emergency-stop button at any time.  			
			5	**Developmental Assessment**	**-**	**-**	**-**	**Assessment Review and corrective action**			3
			6	**Industry Class+ Assignment** **PLC programming**	**2**		**3**				
2	1	2,3,4	1	**Peer discussion on Industrial assignment**		4		Shift register Instructions Practice of Instructions	1		2

			2	Develop and Test a **LAD/FBD** for the given system using simulation software. Identify and select sensors, switches and actuators required to implement the sytem. Empty bottle detection and rejection.  A start pushbutton (NO) is used to start the conveyor and a stop pushbutton (NC) is used to stop. Sensor B detects a product on the conveyor belt and sensor A will detect if it is too large and needs to be rejected. The product is tracked along the conveyor belt and when under the reject station the Reject Blow Off will expel the bad product. The product is randomly placed on the conveyor belt, so an incremental encoder is used to track the conveyor movement. The reset pushbutton (NO) will signal that all of the product on the conveyor has been removed between the sensors and reject blow-off.	1		3	Develop and test a **LAD /FBD** using simulation software to sort three different types of jobs. **identify sensors, switches and actuators required to implement the sytem.** 			3
	1	2,3	3	**Program Control Instructions:** Jump Instructions, Subroutine Instructions, Calling a Subroutine With Parameters. **Comparison Instructions in PLC Programming.** Equal (EQU) Instruction	2		2	**Automatic Bottle Filling System using PLC.** Develop and Test a LAD for this system using simulation software. Identify and select sensors ,switches and actuators required to implement the sytem.			3

				Not Equal (NEQ) Instruction Less than (LES) Instruction Less Than or Equal (LEQ) Instruction. Greater Than (GRT) Instruction. Greater than or Equal (GEQ) Instruction. Limit Test (LIM) Instruction.							
	1	2,3,4	4	**Math Instructions:** Multiply Integer to Double Integer and Divide Integer with Remainder, Multiply Integer to Double Integer and Divide Integer with Remainder, Increment and Decrement Instructions. MOV and Masked MOVE instructions Practice of Instructions	2		2	**Develop LAD/ Functional Block Diagram (FBD) for the parking lot controller by using math instructions. Do not use counter instructions? Identify and select sensors ,switches and actuators required to implement the sytem.** The parking lot which has a capacity of 100 cars is to be controlled by a PLC system. The sensor S1 and S2 are used to count the car at the entrance and exit. If the number of the cars reaches to 100, red light is lit and the gate arm is closed. The arm stays closed until one or more parking space is available in the lot. The gate arm is controlled by activating/deactivating the gate solenoid (GS).			3

											
			5	**Developmental Assessment**	**-**	**-**		**Assessment Review and corrective action**			
			6	**Industry Class + Assignment (PLC programming)**	**2**		**3**				
3	2	4	1	**Peer discussion on Industrial assignment.**		4		**Making and wiring of PLC based control panel** The Evolution of PLCs in Industrial Automation. • Identify different types of PLCs • Identify different brands of PLCs • Comparison of different brands of PLCs • Selection of PLC for given industrial application	1		2

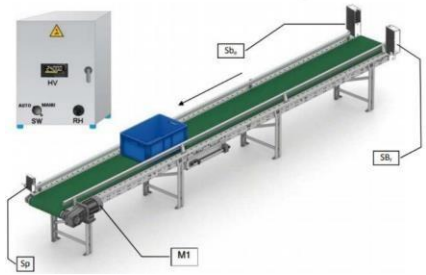
	2	4	2	**Elements of logic panel:** DIN rail for equipment, mounting, Cable channel. Terminal for wire connection, VFD, PLC, Power supply, SMPS. Relay, Contactor, Fan, Connectors, Input outputs module, Power sockets, Transformer, HMI, Selector switch, Push button, Indicating lamp, etc.	1		3	• Safety measures for PLC installations in control panels. • Demonstrate all tools that are required for making the PLC control panel.			3
	2	4	3	To cut DIN rail as per our requirements and fixed in the control panel	1		3	To Mount different devices on DIN rail			3
	2	4	4	• To connect all equipment by different types of cables. • Check all connections before powering on the control panel multimeter.	1		3	Demonstration of SMPS and their connections			3
			5	**CIE 1– Written and practice test**	**-**	**-**	-	**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment (PLC control panel)**	**2**		3				
4	2	4	1	**Peer discussion on Industrial assignment**		4		**Installation, Troubleshooting and maintenance of PLC** • Safety precautions when installing PLC systems. • Power requirements and safety circuitry • Power requirements: Common AC Source. Isolation Transformers. Safety circuitry: Emergency Stops, Master control relay (MCR) and safety control relay (SCR), Emergency Power Disconnect.	1		2

	2	4	2	• I/o installation, wiring, and precautions • I/o module installation, • Wiring considerations: wire size, wire and terminal labelling. Wire bundling. Wire bundling • Wiring procedures • Special i/o connection precaution:	1		3	**PLC START-UP AND CHECKING PROCEDURES:** Static input wiring check, static output wiring check, dynamic system checkout			3
	2	4	3	• PLC system maintenance: preventive maintenance: guidelines for preventive measures: spare parts, replacement of I/O modules. • Common Causes of Programmable Logic Controller Failure • Classification of Faults in a PLC System. • Trouble shooting of Hardware faults	1		3	Troubleshooting the PLC system: • Troubleshooting ground loops • Diagnostic indicators • Troubleshooting plc inputs • Troubleshooting plc outputs • Troubleshooting the CPU • Troubleshooting Specific Components of the PLC System • Power Supply Trouble shooting • Troubleshooting PLC Program Errors • Troubleshooting the Working Environment of a PLC			3
	2	4	4	**Types of software faults** Access various troubleshooting resources provided in the software to diagnose the faults with the PLC system.	1		3	Access various troubleshooting resources provided in the software to diagnose the faults with the PLC system.			3
			5	**Developmental Assessment**		-		**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment (Trouble shooting of PLC)**			3				
Week	**C O**	**P O**	**Days**	**1st session (9am to 1 pm)**	**L**	**T**	**P**	**2ND session (1.30pm to 4.30pm)**	**L**	**T**	**P**
5	3	1	1	**Peer discussion on Industrial assignment**		4		**VFD** • Familiarizing AC motor speed is controlled using the voltage or frequency.	2		1

								• Familiarizing constant flux density. And AC induction motors.			
	3	4	2	• Building blocks of VFDs, specifications, types and working principles. • Torque/current Vs frequency characteristics. • Sizing of VFD • VFD with motor control panel, modules of VFD. • Industrial and domestic applications of VFDs. • Selection of VFD for a given application.	2		2	Wire and test VFD with motor control panel			3
	3	4	3	• Test the communication port, cable and module of VFD. • Connect and Commission the given VFD • Configure and run the motor with factory settings. • Troubleshooting of VFD.	1		3	**Mounting of Variable Frequency Drive** To operate Variable Frequency Drive. Set and control the speed of motor by VFD.			3
	3	4	4	**Diagnose the simulated faults and explore the remedial measures of AC drives.** • Connection of Variable Frequency Drive with PLC and motor	1		3	**Motor Speed Control using VFD and PLC**			3
			5	**CIE 2– Written and practice test**	-	-		**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment** **(Industrial application of VFD)**	**2**		**3**				
6	3	1	1	**Peer discussion on Industrial assignment**		4		**Servo motors:** • Fundamentals of Servo motors and motion control applications. • Servo motors, specifications	1		2

								• servo drives and AC Drives, principle of operation and its applications in motion control, precision measurements etc. • Demonstration of servo motor applications.			
	3	4	2	**Wire and test Servo drive.** Connect and Commission the given servo Drive. • Servo drive for electric mobility application Unguided vehicle(UGV) • Servo drive for robotic applications	1		3	Configure and run the motor with factory settings.			3
	3	4	3	• Diagnose the simulated faults and explore the remedial measures of servo drives.	1		3	• Various communication standards and protocols used in Drives. • Communication cables and adapters. • Various Fault diagnosis in the communication modules.	1		2
	3	4	4	• Connect the Drive with a computer, configure and establish communication. • Configure the drive for various applications using the software. • Troubleshooting of Servo drive.	1		3	• Monitor various motor parameters using the given drive software.			3
			5	**Developmental Assessment**	**-**	**-**		**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment (Industrial application of servomotor)**	**2**		**3**				
Week	**C O**	**P O**	**Days**	**1st session (9am to 1 pm)**	**L**	**T**	**P**	**2ND session (1.30pm to 4.30pm)**	**L**	**T**	**P**
7	5	4	1	**Peer discussion on Industrial assignment**		4		**PLC with colour Touch screen Human Machine Interface (HMI):**	1		2

								• Colour Touch Screen HMI panels and specifications, various industry interfaces on HMI panels, features of HMI panels				
	5	4	2	Working with HMI software Tool • Configure PLC with HMI • Animation with graphical objects • Troubleshooting of communication problems with drive/PLC • Set up and configure HMI with PLC and Perform supervisory control to turn on/off output field devices -1	2		2	Set up and configure HMI with PLC and Perform supervisory control to turn on/off output field devices -2			3	
	5	4	3	• Animate objects on a HMI screen to monitor motor status. • Trend the data of a process parameter using a trend tool.	1		3	• Create user groups and monitor screens with proper authentication. • Use security features to do tag logging and command execution.			3	
	5	4	4	• Control the servo motor from PLC on a network for various operations such as acceleration, and deceleration. • Configure a servo Drive from the given PLC and Control the motor speed for fixed steps for indexing operations and integrate the given PLC, SCADA/HMI and VFD systems to automate the given process. -1	1		3	Configure a servo Drive from the given PLC and Control the motor speed for fixed steps for indexing operations and integrate the given PLC, SCADA/HMI and VFD systems to automate the given process. -2			3	
			5	**CIE 3 Written and practice test**				**Assessment Review and corrective action**			3	
			6	**Industry Class + Assignment (Integrate HMI with PLC)**	**2**		**3**					
8	4	1	1	**Peer discussion on Industrial assignment.**		4		**Introduction to basic pneumatic components**	2		1	

	4	4	2	**Wire, program and automate a working model Applications**. : Wiring and identifying the sensors and valves in the batch process reactor plant and programming it for mixing of the two ingredients-1 OR Design, construct, install, configure, test and demonstrate the operation of an industrial conveyor of empty boxes -1  Description of operation: • If there is no box to convey, the device is off; • If a box is detected by Sb, the conveyor is turned on and the speed of the treadmill must be reached in 5 seconds; • The box is conveyed at a speed of 25 cm/s in auto mode; • Speed can be regulated by user in manual mode with a potentiometer and displayed on the front door of the control box;	1		3	**Wire, program and automate a working model Applications**. : Wiring and identifying the sensors and valves in the batch process reactor plant and programming it for mixing of the two ingredients-2 OR Design, construct, install, configure, test and demonstrate the operation of an industrial conveyor of empty boxes -2			3

				• The conveyor is turned off if the box finished its course on the treadmill detected by sensor Sp AND no new box has been inserted for 10 seconds; Description of contents • M1 is a three-phase asynchronous motor 230 V / 400 V, 0, 18 kW; • Sp is a photo-electric sensor, diffuse system, 24 VDC, negative; • Sb is a photo-electric sensor, thru-beam, (Sbe = Emitter; Sbr = Receiver) 24 VDC, negative • SW is a selector switches with 2 NO contacts and standard or long handle. • RH is a potentiometer to regulate speed in manual mode; • Speed driver is a SCHNEIDER Altivar ATV12 H018 M3; • HV is a digital display of the speed.							
	4	4	3	**Wire, program and automate a working model Applications**: Automatic sorting station.-1	1		3	**Wire, program and automate a working model Applications** : Automatic sorting station.-2			3
	4	4	4	**Wire, program and automate a working model Applications**. : PLC based Automatic Packaging System-1.	1		3	**Wire, program and automate a working model Applications**. : PLC based Automatic Packaging System-2.			3
			5	**Developmental Assessment**				**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment (Automating industrial process)**	**2**		**3**				

9	4	1	1	Weekly Assignment review	-	4	-	**Introduction to IOT** • Main components used in IoT • Ways of building IoT: • Characteristics of IoT: • Modern Applications**:** Demonstrate application of IoT	2		1
	4	1	2	• Communication devices in IoT • Needs for setting up IoT environment for basic applications • Choosing a platform for IoT development • AWS IoT: (Amazon Web Services) • Microsoft Azure IoT: • Choosing IoT hardware processor: • Arduino -Set up – procedure, Advantages: • Raspberry Pi - Set up – procedure, Advantages: • Need to use Bluetooth beacons	2		2	• Introduction to NODE MCU ESP8266 (WIFI module) • Automate a system to control appliances from anywhere through the internet.	1		3
	4	1,4	3	IoT-based Smart Energy Meter using NodeMCU ESP8266	1		3	• What is Raspberry pi and why is it important for IoT • IoT-based Smart Energy Meter using Rasberry PI			3
	4	4	4	• IoT-Based Home Appliances Control with Adafruit IO and Raspberry Pi	1		3	• **Applying IoT technologies in the Electric Power Industry** • **IIoT in Industrial Automation** The essentials of an Industrial IoT solution	1		2

				• IoT-based Home Automation using Blynk App and Raspberry PI				• Practical Industrial IoT examples for daily use			
	4		5	**CIE 4 Written and practice test**	-	-	-	**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment (Automating industrial process)**	**2**		**3**				

Week	C O	P O	Days	1st session (9am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P
10	5	4	1	**Peer discussion on Industrial assignment**		**4**		**Interconnect PLC systems with different industry standard communication protocols for data transfer.** • Need for Industrial networking • brief history • Different types of networking architecture • Topology	3		
	5	1	2	• OSI model of networking • Networking hardware **Network standards** • Modbus, • CAN bus, • ControlNet, • Ethernet, • Profibus • FIP I/O, etc	4			**Proprietary Network standards and protocols**: Master Slave Configurations.	3		
	5	4	3	• Communication Driver software and Communication hardware modules • Network / communication driver software install and settings for PLC and SCADA.			4	• Remote Terminal Units. . • Scheme of Remote I/O	3		

	5	4	4	Demonstrate Industrial Automation Communication Protocols - RS232-422-485 standards			4	Demonstrate HART and MODBUS, PROFIBUS, DH-485 and Foundation fieldbus etc.			3
			5	**Developmental Assessment**				**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment (Industry standard communication standards)**	**2**		**3**				
Week	**C O**	**P O**	**Days**	**1st session (9am to 1 pm)**	**L**	**T**	**P**	**2ND session (1.30pm to 4.30pm)**	**L**	**T**	**P**
11	5	1	1	**Peer discussion on Industrial assignment**		4		**Supervisory data control and acquisition system (SCADA)** **Introduction to SCADA:** • What is SCADA? • SCADA SYSTEMS • Evolution of SCADA • Objective of SCADA. • Benefits of SCADA • Functions of SCADA: • SCADA APPLICATIONS • Usage of SCADA • Real-Time Monitoring and Control using SCADA	3		
	5	4	2	**SCADA HARDWARE**: • SCADA Hardware Functions, • Remote Terminal Units (RTU): RTU Hardware: A typical single-board RTU. • Hardware functionality in an RTU, RTU Software functions • Basic operation: RTU Standards. • Difference between PLC and RTU • Features of SCADA	2		2	**SOFTWARE AND PROTOCOLS**. • DNP3 Protocol: Important Features of DNP3. • IEC60870 PROTOCOL The two widely used protocols for SCADA Applications : • HDLC (High-Level Data Link Control) • MODBUS The widely-used open software for SCADA systems : • Citect and Wonderware.			3

				• Configuration for SCADA environment and applications. • SCADA Software Introduction.							
	5	4	3	• Simple Digital System implementation in SCADA software. • Simple analog System implementation in SCADA software	1		3	Create SCADA Animation in SCADA software			3
	5	4	4	Conveyor Animation Example in SCADA	1		3	Visibility Concept in SCADA			3
		4	**5**	**CIE 5 Written and practice test**	**-**	**-**		**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment**	**2**		**3**				
Week	**C O**	**P O**	**Days**	**1st session (9am to 1 pm)**	**L**	**T**	**P**	**2ND session (1.30pm to 4.30pm)**	**L**	**T**	**P**
12	5	4	1	**Peer discussion on Industrial assignment**		4		• Interfacing of SCADA with PLC • Master Terminal Unit (MTU) • Remote Terminal Unit (RTU)	1		2
	5	4	2	**Control PLC from SCADA** • PLC ladder logic to control variable frequency drive (VFD) for motor speed control with speed selection from Field Local Panel or SCADA graphics.-1	1		3	**Control PLC from SCADA** PLC ladder logic to control variable frequency drive (VFD) for motor speed control with speed selection from Field Local Panel or SCADA graphics-2			3
	5	4	3	Digital Alarms Interfacing with PLC	1		3	Analog Alarms Virtual Simulation			3
	5	4	4	Analog Alarms Interfacing with PLC Basic Report Generation-1	1		3	Analog Alarms Interfacing with PLC Basic Report Generation-2			3
			5	**Developmental Assessment**				**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment (Application of SCADA in automation)**	**2**		**3**				

Week	C O	P O	Days	1st session (9am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P
13	1,2, 3,4, 5	2,3, 4		**Internship** a) Secondary research on various industries and their operations to identify at least 3 companies along with the areas of work interest and develop an internship plan that clearly highlights expectations from the industry during the internship. b) Design and develop a cover letter for an internship request to all 3 identified companies and the resume to be submitted to potential companies. c) Prepare for an internship interview to highlight your interests, areas of study, career aspirations and personnel competence – including the areas of learning you expect to learn during the internship		4		**Project** a) Identification of the problem statement (from at least 3 known problems) the students would like to work as part of the project – either as provided by faculty or as identified by the student. Document the impact the project will have from a technical, social and business perspective. b) Design and develop the project solution or methodology to be used to solve at least one of the problems identified. Prepare a project plan that will include a schedule, WBS, Budget and known risks along with strategies to mitigate them to ensure the project achieves the desired outcome.			3

Reference:

Sl. No.	Description
1	Programmable Logic Controllers: John W.Webb, Ronald A.Reis, PHI
2	Introduction to PLC by Gary Dunning, Cengage Learning.
3	Mechatronics: W.Bolton
4	Control of Machines- S.K. Bhattacharya & Brijinder Singh, New Age International Publishers
5	https://foodsafetytech.com/column/automation-benefits-food-beverage-industry/
6	PLC Handbook https://cdn.automationdirect.com/static/eBooks/PLC%20Handbook.pdf
7	https://www.electrical4u.com/industrial-automation
8	https://support.industry.siemens.com/cs/document/109782616/logo!-soft-comfort-v8-demo?dti=0&lc=en-WW
9	https://new.siemens.com/in/en/products/automation/systems/industrial/plc/logo/logo-demosoftware.html

10	Programming a daily timer on LOGO PLC: https://www.youtube.com/watch?v=Rl2VIBUVr-0
11	Siemens Logo 8 Pump Start & Stop Control With Set Pressure: https://www.youtube.com/watch?v=gf0ZwrVvn_4
12	https://nptel.ac.in/content/storage2/courses/112106175/downloads/Module%204/SELF%20EVALAUTION/SE-Lecture%2041.pdf
13	https://accautomation.ca/wiring-push-buttons-and-selector-switch-to-click-plc/
14	https://realpars.com/discrete-sensors-part-1/
15	https://www.automationdirect.com/adc/overview/catalog/sensors_-z-_encoders
16	https://www.rtautomation.com/technologies/control-iec-61131-3/
17	https://davidrojasticsplc.files.wordpress.com/2009/01/libro-en-espanol.pdf
18	https://instrumentationblog.com/bit-logic-plc-programming-examples/
19	https://accautomation.ca/plc-programming-example-shift-register-conveyor-reject/
20	https://instrumentationtools.com/plc-program-for-counting-moving-objects-on-conveyor/
21	https://accautomation.ca/plc-programming-example-process-mixer/
22	https://automationforum.co/plc-program-batch-process/
23	https://instrumentationtools.com/plc-program-for-mixing-tank/#:~:text=When%20the%20normally%20closed%20%EF%AC%82oat,mix%20the%20two%20liquids%20together.
24	https://accautomation.ca/plc-programming-example-sorting-station-shift-register/
25	https://instrumentationtools.com/car-parking-system-plc-programming/
26	https://learn.automationcommunity.com/car-parking-plc-program/
27	https://www.sanfoundry.com/plc-program-remove-empty-detected-bottle-conveyor/
28	Automatic bottle filling and capping: https://www.youtube.com/watch?v=JdXzMI1PXcs
29	https://instrumentationtools.com/plc-program-to-control-level-of-two-tanks/
30	https://www.reliance-scada.com/en/download/reliance4/reliance4-example-projects
31	https://electrical-engineering-portal.com/plc-troubleshooting
32	https://www.plctutorialpoint.com/2016/05/plc-fault-finding-troubleshooting.html
33	https://instrumentationtools.com/hardware-troubleshooting-steps-for-plc-automation-systems/
34	https://instrumentationtools.com/how-modbus-communication-works/
35	https://instrumentationtools.com/plc-program-to-control-motor-speed-using-vfd-drive/
36	https://instrumentationtools.com/how-to-control-vfd-with-plc/
37	https://realpars.com/connect-vfd-to-plc/
38	https://forumautomation.com/t/plc-selection-criterias/4383
39	https://www.plctechnician.com/news-blog/evolution-plcs
40	SCADA applications in manufacturing | SCADA process control systems: https://www.youtube.com/watch?v=fObw2DE-cos&list=RDCMUCFnjTv9IIHl0Pk6u_i8CJWQ&index=6
41	SCADA colour mixing recipe management: https://www.youtube.com/watch?v=S6giv9rIRNA&list=RDCMUCFnjTv9IIHl0Pk6u_i8CJWQ&index=13
42	Introduction to SCADA System | Supervisory Control and Data Acquisition System: https://www.youtube.com/watch?v=86uY3TQq2Yk https://nptel.ac.in/courses/108106022

43	https://bin95.com/industrial-training-videos/ab-plc-dh485-rs232-usb.htm
44	https://www.geeksforgeeks.org/introduction-to-internet-of-things-iot-set-1/
45	**Introduction to IOT** **a.**https://infyspringboard.onwingspan.com/web/en/viewer/video/lex_auth_012812710727385088146 73_shared?collectionId=lex_auth_01309442655 35569922151_shared&collectionType=Course **b.**https://www.geeksforgeeks.org/internet-things-iot-2/
46	Introduction to NODE MCU ESP8266 (WIFI module) https://www.nodemcu.com/index_en.html Automation system to control appliances from anywhere through the internet. https://easyelectronicsproject.com/esp32-projects/esp8266-mqtt-home-automation-system/
47	IoT based Smart Energy Meter using NodeMCU ESP8266 https://iotdesignpro.com/projects/iot-based-smart-energy-meter-using-nodemcu-esp8266 https://iotdesignpro.com/projects/iot-based-smart-energy-meter
48	What is Raspberry pi and why is it important for IoT https://analyticsindiamag.com/raspberry-pie-important-iot/ IoT based Smart Energy Meter using Rasberry pi https://circuitdigest.com/microcontroller-projects/iot-based-raspberry-pi-smart-energy-meter
49	IoT Based Home Appliances Control with Adafruit IO and Raspberry Pi https://iotdesignpro.com/iot-based-home-appliances-control-adafruit-io-and-raspberry-pi **IoT based Home Automation using Blynk App and Raspberry Pi** https://iotdesignpro.com/raspberry-pi-projects?page=4
50	**Applying IoT technologies in the Electric Power Industry** https://www2.deloitte.com/xe/en/insights/focus/internet-of-things/iot-in-electric-power-industry.html
51	Practical Industrial IoT examples for daily use https://www.ixon.cloud/knowledge-hub/7-practical-applications-of-iiot-in-industrial-automation
52	https://instrumentationtools.com/problem-on-plc-hmi-vfd-and-motor-circuit/
53	**PLC Troubleshooting** https://electrical-engineering-portal.com/plc-troubleshooting https://www.dosupply.com/tech/2022/06/01/plc-troubleshooting-flowchart-and-explanation/
54	https://instrumentationtools.com/hardware-troubleshooting-steps-for-plc-automation-systems/#h-how-to-troubleshoot-the-plc-hardware-faults
55	https://www.electricityforum.com/iep/electric-motors-and-drives/vfd-sizing https://www.focusondrives.com/how-do-you-size-a-vfd/

	https://www.elitecontrols.us/how-do-you-size-a-variable-frequency-drive-vfd/ http://www.vfds.org/vfd-application-guide-379829.html
56	https://instrumentationtools.com/vfd-commissioning-and-testing-procedure-variable-frequency-drive/
57	VFD www.newark.com › agilent › TroubleshootingVFD cdn.logic-control.com › media › abb https://www.pesquality.com/blog/general-troubleshooting-of-vfd-problems https://instrumentationtools.com/how-to-control-vfd-with-plc/
58	https://www.ato.com/servo-drive-troubleshooting https://gesrepair.com/servo-motor-drive-troubleshooting-guide/
59	https://instrumentationtools.com/fieldbus-profibus-hart-protocols/

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS

Course Code- **L:T:P-**

Course Description:

This course provides polytechnic students with a foundational understanding of the entrepreneurial mindset, processes, and skills required to identify opportunities, develop innovative solutions, and create sustainable ventures. Throughout the semester, Critical Thinking, Excellent communicator (Good story teller), and Empathetic Leadership skills development for the students, through a blend of theoretical concepts, case studies, and practical exercises, students will learn to think like entrepreneurs, fostering creativity, problem-solving, and a proactive approach to career and economic development. The course emphasizes practical tools and methodologies applicable across various technical and vocational fields. This course will focus towards small Businesses including services and products

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Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

1. **Define and explain** core concepts of entrepreneurship, innovation, and small business management.
2. **Identify and evaluate** entrepreneurial opportunities using various ideation and market research techniques.
3. **Develop a basic business model** using tools like the Business Model Canvas.
4. **Understand fundamental aspects** of market analysis, competitive landscape, and target customer identification.
5. **Articulate key considerations** in managing startup finances, legal structures, and intellectual property.
6. **Develop and deliver a compelling pitch** for a new business idea.
7. **Cultivate an entrepreneurial mindset**, including adaptability, resilience, and a willingness to take calculated risks.

Course Content Outline (Weekly Breakdown):

Unit 1: Understanding Entrepreneurship and the Entrepreneurial Mindset (Weeks 1-2)

- **Week 1: What is Entrepreneurship? The Journey Begins.**
    - Definition of entrepreneurship, innovation, and intrapreneurship.
    - Dispelling myths about entrepreneurs.
    - The role of entrepreneurship in economic development and job creation (local and global context).
    - Types of entrepreneurships: lifestyle, scalable, social, tech, side-hustle.
    - Introduction to JUT's entrepreneurial ecosystem and local success stories
    - ***Activity:*** **Ice-breaker: "What problem bothers you the most in your daily life/local community?"**

- **Week 2: The Entrepreneurial Mindset & Traits of Successful Entrepreneurs.**
    - Key entrepreneurial characteristics: passion, resilience, adaptability, creativity, risk-taking (calculated), problem-solving.
    - Growth mindset vs. fixed mindset.
    - Identifying personal strengths and weaknesses as potential entrepreneurs.
    - Importance of networking and mentorship.
    - *Case Study:* Analyze a local polytechnic graduate who started a successful business.
    - ***Activity:*** **Self-assessment quiz: "Are you ready for entrepreneurship?"**

Unit 2: Opportunity Identification & Ideation (Weeks 3-4)

- **Week 3: Finding Your Big Idea: Problem-Solving Approach.**
    - Sources of entrepreneurial opportunities: pain points, market gaps, trends, technological advancements, personal hobbies/skills.
    - Design Thinking principles for problem identification.
    - Techniques for observing and understanding customer needs (empathy mapping).
    - ***Activity:*** **Field observation exercise: Identify 3 problems in a chosen environment (e.g., campus, local market).**
- **Week 4: Ideation & Validation Techniques.**
    - Brainstorming methods: SCAMPER, S- Substitute, C-Combine, A- Adapt, M- Modify, P-Put to another Use, E-Eliminate, R- Reverse/Rearrange (Mind Mapping, Reverse Brainstorming)
    - Concept generation and prototyping
    - Introduction to Minimum Viable Product (MVP) concept.
    - Initial idea validation: informal surveys, interviews with potential customers.
    - ***Activity:*** **Group ideation session for a chosen problem; develop a basic MVP concept.**

Unit 3: Business Model Fundamentals (Weeks 5-6)

- **Week 5: Introduction to the Business Model Canvas (BMC).**
    - Understanding the nine building blocks of the BMC: Customer Segments, Value Propositions, Channels, Customer Relationships, Revenue Streams, Key Resources, Key Activities, Key Partnerships, Cost Structure.
    - How the BMC provides a holistic view of a business.
    - *Activity:* Analyze the BMC of a well-known local or global company.
- **Week 6: Developing Your Value Proposition & Customer Segments.**
    - Deep dive into Value Proposition Design: understanding customer jobs, pains, and gains.
    - Defining your ideal customer segments: demographics, psychographics, behaviors.
    - Niche markets vs. broad markets.
    - ***Activity:*** **Students start populating the Customer Segments and Value Propositions blocks of their own business idea's BMC.**

Unit 4: Market Analysis & Strategy (Weeks 7-8)

- **Week 7: Market Research Essentials.**
    - Importance of market research: primary vs. secondary research.
    - Basic tools for market research: online surveys (e.g., Google Forms), competitor analysis, industry reports.
    - Analyzing market size, trends, and growth potential.

    - ***Activity:*** **Conduct preliminary secondary market research for their chosen industry.**
- **Week 8: Understanding Your Competition & Marketing Basics.**
    - Competitor analysis: identifying direct and indirect competitors, SWOT analysis (Strength, Weakness, Opportunity, Threat).
    - Developing a competitive advantage.
    - Introduction to the Marketing Mix (4 Ps: Product, Price, Place, Promotion) in a startup context.
    - Branding basics for new ventures.
    - *Guest Speaker (Optional):* Local entrepreneur sharing marketing strategies.

Unit 5: Financial, Legal & Operational Foundations (Weeks 9-11)

- **Week 9: Startup Financial Basics.**
    - Understanding startup costs (fixed vs. variable).
    - Revenue models: how businesses make money.
    - Basic concepts of pricing strategies.
    - Sources of funding: bootstrapping, FFF (Friends, Family, Bootstrap), grants, basic loans, angel investors (brief overview).
    - ***Activity:*** **Calculate initial startup costs for their business idea.**
- **Week 10: Legal & Regulatory Aspects for Startups.**
    - Choosing a business structure: Sole Proprietorship, Partnership, LLC (simple overview, focus on local context).
    - Importance of business registration and licensing.
    - Basic understanding of contracts and agreements.
    - Introduction to Intellectual Property (IP): patents, trademarks, copyrights (relevance to polytechnic innovations).
    - *Guest Speaker (Optional):* Small business lawyer or a representative from a local business registration office.
- **Week 11: Operations & Team Building.**
    - Key operational considerations: supply chain, production/service delivery, quality control.
    - Building an effective founding team: complementary skills, roles, and responsibilities.
    - Importance of company culture in a startup.
    - ***Activity:*** **Define key activities and key partners for their BMC.**

Unit 6: Pitching, Growth, and Next Steps (Weeks 12-14)

- **Week 12: Crafting Your Pitch & Storytelling.**
    - Purpose of a pitch deck.
    - Components of a compelling pitch: problem, solution, market, team, business model, ask.
    - Storytelling techniques for engaging an audience.
    - Verbal and non-verbal communication skills.
    - *Activity:* Students draft their initial pitch script.
- **Week 13: Developing Your Business Plan (Lean Approach) & Refining Your Pitch.**
    - Overview of a lean business plan (as opposed to a traditional, lengthy one).
    - Refining the Business Model Canvas into a more comprehensive plan.
    - Peer feedback session on draft pitches.
    - ***Workshop:*** **Pitch practice session.**
- **Week 14: Final Pitch Presentations & Future Directions.**
    - **Final Project:** Students present their business idea pitch (could be 5-7 minutes with Q&A).
    - Discussion on continuous learning, adaptation, and potential next steps for their entrepreneurial journey.

- Resources available for aspiring entrepreneurs at JUT and in the local community.
- *Activity:* Course wrap-up and Q&A.

Assessment Methods:

To ensure a balance between theoretical understanding and practical application, the assessment for this course could include:

- **Participation & Engagement (10-15%):** Active involvement in discussions, group activities, and case study analyses.
- **Module Activities/Quizzes (20-25%):** Short quizzes, completion of assigned BMC sections, market research exercises, ideation assignments.
- **Individual/Group Assignments (30-35%):**
  - **Mid-Term Assignment:** Developed Business Model Canvas for their chosen idea (could be individual or small groups).
  - **Research Report:** A brief report on their market research and competitive analysis.
- **Final Project (30-35%):**
  - **Business Pitch Deck:** A professional-looking presentation outlining their business idea.
  - **Oral Pitch Presentation:** Delivering a concise and compelling pitch to the class (and potentially invited faculty/local entrepreneurs).

Recommended Resources & Tools:

- **Primary Textbook**
- **Online Platforms/Tools: Introduction to Entrepreneurship Dr Prakah Kumar, Raj Jaswa, Ramesh Yadava**
  - Google Workspace (Docs, Sheets, Slides, Forms) for collaboration and surveys. Canva for creating visual aids and pitch decks. URL **https://www.canva.com/**
  - **web.showreelapp.com** Sabeer Bhatia
  - Online market research tools (e.g., Statista, government statistical websites, industry association sites).
  - Whiteboards, sticky notes, and markers for brainstorming sessions.
- **Guest Speakers:** Local entrepreneurs, business development agencies, IP lawyers, startup mentors.

Case Studies: A mix of successful and failed startups, particularly those relevant to polytechnic fields (e.g., tech, engineering, design, trades).

ELECTRIC VEHICLE

Course Code- **L:T:P**

I. RATIONALE

The global movement towards sustainable energy has positioned electric vehicle (EV) technology as a crucial field for electrical engineers. This course is designed to provide students with the essential knowledge and skills to understand, test, and work with EV systems. Through a blend of theoretical instruction and hands-on laboratory experiments, students will develop a thorough understanding of EV technology, equipping them for careers in the rapidly expanding electric vehicle industry.

II. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1 - Identify components and subsystems used in electric vehicles. CO2 - Select electrical drives for particular EV application.
CO3 - Test the performance of batteries and energy storage systems used for EV applications.
CO4 - Apply the concept of converters and charging system in EV.
CO5 - Implement Indian and state EV policies for EV applications.

III. COURSE CONTENT

Unit	Course Content	Hours
1	**Unit - I Basics of Electric Vehicles** 1.1 History and evolution of electric vehicles (EV), need of EV, Electric vehicles and internal combustion engine vehicles: Comparison on the basis of environmental impact, power source, maintenance, gear change, noise level, vibrations level, capital cost, and running cost. 1.2 Electric vehicle architecture, Types of EV: Battery Electric Vehicle (BEV), Hybrid Electric Vehicle (HEV), Plug-in Hybrid Electric Vehicle (PHEV), Fuel Cell Electric Vehicle (FCEV). 1.3 Comparison of different electric vehicle types on the basis of Driving Component, Energy Source used, Features, Problems and models available in market. 1.4 Block diagram of EV subsystems: energy source subsystem, propulsion subsystem and auxiliary subsystem.	

2	**Unit - II Electric Vehicle Drives** 2.1 Classification of electric drives used in EV: DC Motor drives, AC Motor drives. 2.2 Brushed DC Motor, Brushless DC Motor (BLDC), Permanent Magnet Synchronous Motor (PMSM), Induction Motor (IM), Synchronous Reluctance Motor (SynRM), PM Assisted Synchronous Reluctance Motor, Axial Flux Ironless Permanent Magnet Motor: Salient features, characteristics, advantages, limitations, and usage of different motor types in EV models. 2.3 Comparison of EV motors based on power-weight ratio, torque-speed characteristic, cost of controllers required and cost of motors. 2.4 Physical location of motor in EV, Rating of motors, Connections (Mechanical and Electrical), and Selection criteria of various types of EV motors.	
3	**Unit - III Batteries and Energy Storage Systems** 3.1 Energy storage technology: EV Batteries, Supercapacitors, flywheel energy storage. Battery Parameters: Cell and Battery Voltages, Charge (or Amphour) Capacity, Energy Stored, Specific Energy, Energy Density, Specific Power, Amphour (or Charge) Efficiency, Energy Efficiency, Self-discharge Rates, Battery Geometry, Battery Temperature, Heating and Cooling Needs, Battery Life and Number of Deep Cycles. 3.2 Batteries: Lead-acid, NiMH (Nickel-Metal Hydride), Li-Ion (Lithium-Ion), Ni-Zn (Nickel-Zinc), Ni-Cd (Nickel-Cadmium), Aluminium–Ion batteries (Al–Ion batteries), Aluminium–air batteries (Al–air batteries)- their basic construction components, life time (cycles), efficiency, advantages and disadvantages. Comparison of various batteries. Factors influencing the operation of battery, and selection of battery. Series and Parallel connection of Batteries, Calculation of battery capacity. 3.3 Battery Management Systems (BMS): Need of BMS, Block diagram of BMS, function of each block, Battery Condition Monitoring, “3R” (Reduce, Reuse, Recycle) process for battery. 3.4 Fuel Cell: Difference between fuel cell and batteries, Fuel Cell Terminology: Anode, Cathode, Electrolyte, Catalyst, Reformer, Direct Fuel Cell, Working principle of fuel cell. Types of Fuel Cells used in EVs: Alkaline Fuel Cell (AFC), Polymer Electrolyte Membrane Fuel Cell (PEMFC), Phosphoric Acid Fuel Cell (PAFC), Molten Carbonate Fuel Cell (MCFC), Solid Oxide Fuel cell (SOFC), Their comparison on the basis of Electrolyte type, Cell voltage, Operating temperature, System output (kW), Efficiency (%) and Applications.	

4	**Unit - IV Converters and EV Chargers** 4.1 Introduction to power electronics used in EV, Block diagram of typical EV: Description and Functions of DC to DC Converter, DC to AC Converter, AC to DC Converter (Rectifier) and filters. 4.2 Charging methods: Home charging, Trickle charging, Household AC charging, Public charging (DC Fast charging). 4.3 Charging System: Classification- Wireless, On board and Off board charging, V1G (Uni-directional smart charging), V2B/V2H (Vehicle-to-Building/ Vehicle-to-Home), V2X (Vehicle-to-Everything), V2G (Vehicle-to-Grid, Bi-directional smart charging). 4.4 Charging Stations: Types of charging station, Public charging station: Selection and sizing, components and, single line diagram. Calculation of charging time and concept of battery swapping. Precautions observed while charging.	
5	**Unit - V Electric Vehicle (EV) Policies** 5.1 Goal of EV30@30 campaign. Goals of electric vehicles initiative in India. National Electric Mobility Mission Plan 2020 (NEMMP): Objectives, Steps taken by Indian Government for faster adoption of electric vehicles, Barriers to adoption of electric mobility, E-mobility strategy, NEMMP 2020 Implementation structure. 5.2 Maharashtra Electric Vehicle Policy, 2021: Objectives, Basic demand incentives for electric vehicles, Vehicle segment-wise scrappage incentives, Incentives for charging infrastructure.	

IV. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Mehrdad Ehsani, Yimin Gao, Stefano Longo, and Kambiz Ebrahimi.	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles.	CRC Press, 2019, ISBN 13: 978-0367137465.
2	James Larminie, John Lowry.	Electric Vehicle Technology Explained.	Wiley-Blackwell, 2012, ISBN 13: 978-1119942733
3	Dr. Nitesh Tiwari, Dr. Shekhar Yadav.	Electric Vehicle (Green and Sustainable Transportation).	S.K. Kataria & Sons, 2023, ISBN 13: 987-81-963589-0-7.
4	Ali Emadi, Mehrdad Ehsani, John M. Miller.	Vehicular Electric Power Systems: Land, Sea, Air, and Space Vehicles.	CRC Press, 2003, ISBN 13: 978-0824747510.
5	Sunil R. Pawar.	Electrical Vehicle Technology: The Future Towards Eco-Friendly Technology.	Notion Press Publication, 2021, ISBN 10:1685545610.

V. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://youtu.be/2IgZSDDFW-Y?si=Z1tfZO24ljBppzVA	Identification of terminals of BLDC motor.
2	https://www.niti.gov.in/sites/default/files/2023-02/EV_Handbook_Final_14Oct.pdf	Handbook of electric vehicle charging infrastructure implementation.
3	https://heavyindustries.gov.in/sites/default/files/2023-07/NEMMP-2020.pdf	National Electric Mobility Mission Plan 2020.
4	https://www.cleanenergyministerial.org/initiatives-campaigns/electric-vehicles-initiative/	Goal of EV30@30 campaign.
5	https://maitri.mahaonline.gov.in/PDF/EV%20Policy%20GR%202021.pdf	Maharashtra Electric Vehicle Policy, 2021.
6	https://www.mdpi.com/1996-1073/10/8/1217	Electric vehicle review paper.
7	https://archive.nptel.ac.in/courses/108/103/108103009/	NPTEL electric vehicle course literature.
8	https://onlinecourses.nptel.ac.in/noc22_ee53/preview	NPTEL electric vehicle course videos.
9	https://www.mdpi.com/1996-1073/15/3/1241	DC-AC converters for electric vehicle review paper.
10	https://www.niti.gov.in/sites/default/files/2022-05/Battery_swapping_report_09052022.pdf	Battery swapping.

RENEWABLE ENERGY TECHNOLOGY

Course Code- **L:T:P**

I. RATIONALE

Renewable energy technology has a huge potential in mitigating climate change as well as the gap between power supply and demand and also creating job opportunities. Therefore, Government of India is focusing on the generation of electrical energy through renewable energy sources. This course is designed for diploma students to acquire skills in operating and maintaining the renewable energy technologies for its proper utilization.

II. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1 - Test the performance of the solar panels. CO2 - Maintain working of small wind turbines.
CO3 - Utilize small-capacity hydrogen fuel cell systems for various applications.
CO4 - Maintain basic components of biogas plant.
CO5 - Identify major components of the geothermal, ocean and small hydro power plants.

III. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Unit	COURSE CONTENT	Hours
1	**Unit - I Solar Power Technology** 1.1 Solar radiation: Beam radiation or direct radiation, diffused radiation, insolation, absorption. 1.2 Solar radiation Geometry: Declination, hour Angle, altitude angle, incident angle, zenith angle, solar azimuth angle, surface azimuth angle, day length, local solar time. 1.3 Instruments for measuring solar radiation: Pyrheliometer, Pyranometer, Sunshine recorder; Working principle, types. 1.4 Principle of conversion of solar radiation into: electricity and heat 1.5 Solar Cell: Working Principle, Equivalent Circuit, Current intensity verses output voltage graph 1.6 Solar Cell modules and arrays: Solar cell connecting arrangements 1.7 Basic Photovoltaic system for power generation: Concept and Block Diagram 1.8 Flat plate collectors: Typical liquid collector, Solar Air Heaters; Construction, Working Principle and applications and advantages. 1.9 Solar concentrating collectors: Focusing Type, Non-Focusing Type; Working Principle and applications	
2	**Unit - II Wind Power Technology** 2.1 Basic terminologies: Cut-in, cut-out and survival wind speeds, Threshold wind speeds, Power in wind, Power coefficient, Maximum power and Betz Limit 2.2 Wind Turbine Rotation Principles: Forces on the blades, lift and drag, thrust and torque on wind turbine rotor 2.3 Mathematical Expression Governing Wind Power 2.4 Site selection consideration 2.5 Wind energy conversion system (WECS): Concept, Block diagram, Working principle 2.6 Wind mill: Horizontal axial, Vertical axial, small and large wind turbine. 2.7 Wind power generators: Permanent Magnet DC Generator, Synchronous Generator, Squirrel-Cage rotor Induction Generator (SCIG), Doubly-Fed Induction Generator (DFIG); working principle 2.8 Gearbox arrangement 2.9 Variable speed and constant frequency scheme - Concept and working principle 2.10 Pitch system: Pitch Control and Yaw control	

3	**Unit - III Hydrogen Energy and Fuel cell** 3.1 Hydrogen Production: Electrolyser, Thermochemical Method, Coal Gasification, Photo- electrolysis; Working principle 3.2 Hydrogen Storage and transportation: Need, methods, limitations 3.3 Hydrogen as an alternative fuel for motor vehicle 3.4 Comparison of hydrogen over other fuels 3.5 Handling of Hydrogen: Hazard and its Preventive measures 3.6 Fuel cell: Terminology, working principle, types, main components of fuel cell system, advantages, disadvantages and applications 3.7 Polarization in fuel cell: Concept, Resistance polarization	
4	**Unit - IV Biomass Energy** 4.1 Biomass conversion Process: Anaerobic digestion, Ethanol Fermentation, Pyrolysis, Digestion, Gasification, Hydrolysis 4.2 Materials used for Biogas generation 4.3 Factors affecting Biomass generation 4.4 Classification of Biogas Plant: Continuous and Batch type; Dome and Drum type 4.5 Biogas Plants: KVIC digester; Schematic diagram, construction; Chinese Digester; Concept; Pragati Biogas plant; Schematic diagram, working Principle 4.6 Selection of site for Biogas plant	
5	**Unit - V Other Renewable Sources of Energy** 5.1 Geothermal power plant: General arrangements, types (Dry type, Wet Type and Binary type), working principle, advantages and limitations 5.2 Ocean Energy: Ocean Thermal Electric Conversion, Tidal energy, wave energy, marine current; General arrangement and working principle, Prospects in India 5.3 Small Hydroelectric Power Plant (SHP): Classification; Mini and Micro, General arrangement and working principle, Prospects in India Site selection for the Small Hydroelectric Power Plant	

IV. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Chetan Singh Solanki	Renewable Energy Technologies- A Practical guide for beginners	PHI Learning Pvt. Ltd. ISBN:9788120334342
2	S.P. Sukhatme, Nayak J. K	Solar Energy: Principles of Thermal Collection and Storage	McGraw-Hill Education (India) ISBN:978-0074519462
3	Chetan Singh Solanki	Solar Photovoltaic: Fundamentals, Technologies and Application	PHI Learning Pvt. Ltd. ISBN : 9788120351110, eBook ISBN : 9789390544448
4	Joshua Earnest, Tore Wizelius	Wind Power Plants and Project Development	PHI Learning Pvt. Ltd. ISBN: 978-81-203-5127-1
5	D.P.Kothari, K.C.Singal, Rakesh Ranjan	Renewable Energy Sources and Emerging Technologies	PHI Learning Pvt. Ltd. ISBN: 978-81-203-4470-9
6	Chetan Singh Solanki	Solar Photovoltaic Technology and System: A Manual for Technicians, Trainers and Engineers	PHI Learning Pvt. Ltd. ISBN: 978-81-203-4711-3
7	G.D.Rai	Non Conventional Energy Sources	Khanna Publishers, ISBN:978-8174090737

V. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=jswDvFzGoO4	50 MW Solar Power Plant for NTPC at Rajgarh, Madhya Pradesh
2	https://archive.nptel.ac.in/courses/108/108/108108078/	Non-Conventional Energy Systems by Prof. L. Umanand (IISc Bangalore)
3	https://archive.nptel.ac.in/courses/103/103/103103206/	Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems by Prof. R. Anandalakshmi and Prof. Vaibhav Vasant Goud (IIT Guwahati)
4	https://archive.nptel.ac.in/courses/103/107/103107157/	Technologies For Clean And Renewable Energy Production by Prof. P. Mondal (IIT Roorkee)
5	https://archive.nptel.ac.in/courses/121/106/121106014/	Non-Conventional Energy Resources by Dr. Prathap Haridoss (IIT Madras)
6	https://www.lccc.edu/science-in-motion/labs-equipment/renewable-energy-lab-experiments/	Renewable Energy Lab Experiments

SMART GRID TECHNOLOGY

Course Code- **L:T:P**

Course Objective

To teach the basic concepts, components and architecture of smart grid.
To familiarize the students with the new technologies for grid interfaced DG system with storages.
To explain the communication technologies and the cyber-security threats in Smart Grid.
To teach the fundamental requirements for planning ancillary services in Smart Grid.

Course Outcomes

CO1	Able to understand the features and architecture of Smart Grid.
CO2	Able to assess the role of automation in transmission and distribution.
CO3	Able to understand and analyse the operation of DG and storage technologies.
CO4	Able to understand the communication technologies and cyber-security in Smart Grid.
CO5	Able to understand the planning, operation, control and analysis of Smart Electric Grid.

Course Content

Unit-1

Introduction to Smart Grid:
Introduction, Definition of smart grid, Concept of smart grid structure, Conventional grid Vs. Smart grid, Opportunities & Barriers of Smart Grid, Enablers of smart grid, Smart-grid activities in India, Key Challenges for Smart Grid.

Unit-2

Smart Grid Architecture:
Components and Architecture of Smart Grid Design, Review of the proposed architectures for Smart Grid, Advanced metering infrastructure, The fundamental components of Smart Grid designs –Transmission Automation –Distribution Automation –Renewable Integration.

Unit-3

Distribution Generation Technologies:
Introduction, Introduction to Renewable Energy Technologies, Micro grids, Storage Technologies – Electric Vehicles and PHEVs, Environmental impact and Climate Change, Economic Issues.

Unit-4

Communication Technologies and Smart Grid:
Introduction to Communication Technology – Two way digital communications paradigm, Synchro-Phasor Measurement Units (PMUs), Wide Area Measurement Systems (WAMS), Introduction to Internet of things (IOT) - Applications of IOT in Smart Grid, Cyber Security for Smart Grid.

Unit-5

Smart Grid Planning

Planning aspects of smart grid, Operation and control of AC, DC & hybrid smart grid, Demand side management- Demand response, Energy management, planning of smart grid systems.

References:-

1. J. Ekanayake, N. Jenkins, K. Liyanage, J.Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley, 1st Edition, 2012.

2. Stuart Borlase, Smart Grids, Infrastructure, Technology and Solutions, CRC Press, 1st edition, 2012.

3. Ali Keyhani, "Design of smart power grid renewable energy systems", Wiley IEEE, 3rd Edition, 2019.

4. A.G. Phadke and J.S. Thorp, "Synchronized Phasor Measurements and their Applications", Springer Edition, 2nd Edition, 2017

5. J. A. Momoh, "Smart Grid: Fundamentals of Design and Analysis," Wiley-IEEE Press, 1st Edition, March 2012.

POWER SYSTEM OPERATION & CONTROL

Course Code- **L:T:P**

I. RATIONALE

Electrical power system operation and control plays a significant role in electric power transfer from generation to consumer's end. The diploma engineers working in power sector have to perform operation and control of power system. He should have understanding about the reactive power control strategies, system stability and role of load dispatch center. This course aims to develop the basic knowledge and required skills to maintain the proper functioning of the power system.

II. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1 - Represent power system by reactance diagram using per unit method

CO2 - Manage real and reactive power balance within a power system network.

CO3 - Ensure the effective operation of an automatic generation control system.

CO4 - Apply various techniques to maintain power system stability.

CO5 - Operate and manage a load dispatch center.

III. COURSE CONTENT

Unit	COURSE CONTENT	Hours
1	**Unit - I Representation of Power System.** 1.1 Structure of power system. 1.2 Requirements of stable power system operation. 1.3 Representation of power system by single line diagram, impedance diagram and reactance diagram. 1.4 Concept of per unit method and its advantages. 1.5 Per unit method for representing power system parameters.	
2	**Unit - II Real And Reactive Power Flow** 2.1 Power flow: real power balance and reactive power balance, impact. 2.2 Relation between real power balance and frequency of the system. 2.3 Impact of variation in frequency on consumers and supply agencies (generation plants). 2.4 Relation between reactive power balance and voltage of the system 2.5 Impact of variation in voltage on consumers and supply agencies (generation plants). 2.6 FACT controllers in reactive power compensation: Need. 2.7 Reactive power injection methods by various second-generation FACT devices 2.7.1. Static synchronous series compensator (SSSC) 2.7.2. Static synchronous shunt compensator (STATCOM) 2.7.3. Unified power flow controller (UPFC) 2.7.4. Interline power flow controller (IPFC) (Introduction Only)	

3	**Unit - III Automatic Generation Control** 3.1 Automatic load frequency control (ALFC): Schematic diagram and working. 3.2 Governor controller system- electro hydraulic governor (Digital Governor), Restricted governing mode of operation (RGMO), Free governing mode of operation (FGMO) (Introduction Only) 3.3 Automatic voltage control (AVC): Schematic diagram and working. 3.4 Automatic generation control (AGC): Schematic diagram and working.	
4	**Unit - IV Power System Stability** 4.1 Power system stability, overall stability, stability limit and instability. 4.2 Effects of power system instability. 4.3 Large disturbance and small disturbance. 4.4 Classification of stability: i) Steady state stability ii) Transient state stability iii) Dynamic stability 4.5 Stability studies with the help of power angle diagram. 4.6 Methods of improving steady state and transient state stability condition.	
5	**Unit - V Load Dispatch Centre** 5.1 Load dispatch centre: need and importance. 5.2 Load forecasting: significance, environmental and social factors in load forecasting. 5.3 Types of load dispatch center (NLDC, RLDC, SLDC) and their functions.	

IV. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Nagrath I. J., Kothari D. P.	Modern Power System Analysis	5th Edition, McGraw Hill Education, New Delhi 2003 ISBN-978-9354600968
2	Gangadhar K. A.	Electric Power Systems (Analysis, Stability and Protection)	Khanna Publishers, Delhi. India, 2006. ISBN 9788174090041
3	K.R. Padiyar	Facts Controllers in Power Transmission and Distribution	3rd Edition, New Age International Private Limited, 2006. ISBN 978-9389802047
4	Abhijit Chakrabarty	Power System Analysis, operation and control	PHI Learning, New Delhi, New Delhi, 2010 ISBN: 788120340152
5	Chakrabarti, D P A Kothari, A K Mukhopadhyay, D E Abhinandan	An introduction to Reactive Power Control and Voltage Stability in Power Transmission Systems	PHI Learning, New Delhi, 2015 ISBN: 9788120340503
6	A. J. Wood, B. F. Woolenberg,	Power Generation Operation and Control	John Wiley and Sons, UK ISBN:978-0-471-79055-6
7	Prabha S. Kundur, Om P. Malik	Power System Stability and Control	2nd Edition, 2022 McGraw Hill ISBN: 9781260473544

V. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://iitr.ac.in/Departments/Hydro%20and%20Renewable%20Energy%20Department/static/Modern_hydroelectric_engg/vol_1/Chapter-6_Hydro-Turbine_Governing_System.pdf	Governor Controller System-ElectroHydraulic Governor (Digital Governor)
2	WRLDC-TP-019-Implementation-of-Free-Governor-Mode-of-Operation-in-Western-Region-of-India-2004.pdf (posoco.in)	Free Governing Mode of Operation (FGMO)
Sr.No	**Link / Portal**	**Description**
3	https://cercind.gov.in/2017/draft_reg/GC-copy/Power%20System%20Operation%20Corporation%20Limited%20(POSOCO).pdf	Details of Restricted governing mode of operation (RGMO) and free governing mode of operation (FGMO)
4	https://posoco.in/reports/monthly-reports/monthly-reports-2024-25/	Statistics and current scenario of NLDC/RLDC/SLDC
5	https://www.mahatransco.in/information/details/load_despatch	Statistics and current scenario of NLDC/RLDC/SLDC
6	https://sa-nitk.vlabs.ac.in/exp/onload-tap-changes/	Control of Bus Voltages Through Onload Tap Changes
7	https://cercind.gov.in/2016/whatsnew/anx1.pdf	Details of Restricted governing mode of operation (RGMO) and free governing mode of operation (FGMO)

POWER ELECTRONICS & DRIVES

Course Code- **L:T:P**

Pre requisites

This course requires the knowledge of Electronics Engineering (Semiconductor devices) Electrical Circuits and Electrical Machines (DC and AC).

Course Outcomes

Upon completion of the course, the student shall be able to

CO1:	Compare different power electronic devices and select the device based on the requirement
CO2 :	Analyze the different Converters circuits and to select suitable converters based on applications field.
CO3:	Acquire the knowledge to construct AC Controllers and Choppers circuits.
CO4:	Acquire the knowledge to construct and use Inverters and Cyclo-converters circuits.
CO5:	Apply the power electronic drives for speed control of DC / AC Motors and compare specific power electronics drives.
CO6:	Apply the Power electronic circuits for specific applications

Course Contents

UNIT 1 - Power Electronic Devices **Duration: 13 Periods (L: 10 - T: 3)**

ISI circuit symbols for each device in thyristor family – Construction, Working principle and static VI characteristics of devices: SCR- Two transistor analogy of SCR , Gate characteristics of SCR, Ratings of SCR: Forward break over voltage, latching current, holding current, turn on time, turn off time – advantages of SCR as switch -static VI characteristics and working of DIAC, TRIAC, IGBT - applications of SCR, GTO SCR, DIAC, TRIAC, IGBT, LASCR -
triggering of SCR using UJT - Necessity of Commutation- various methods of Thyristor Commutation techniques.

UNIT 2– Converters **Duration: 12 Periods (L: 9 – T: 3)**

Classification of converters, Advantages and disadvantages of power electronic converters- single phase half wavecontrolled converter with R load, R-L load, Need of freewheeling diode- single phase half wave controlled converter with R-L load with freewheeling diode, single phase full wave full controlled converter with R load, R-L load - three phase half wave converter with R load.

UNIT 3 – A.C Voltage Controllersand Choppers **Duration:13 Periods (L:10– T: 3)** Single phase half wave and full wave AC voltage controller with R load - Applications of AC voltage controller - Choppers- Classification of Choppers, Four quadrant operation of a chopper, different voltage control modes of operation, Applications of choppers.

UNIT 4 – Inverters & Cyclo-converters **Duration: 12 Periods (L: 9 –T: 3)** Classification of Inverters-basic series Inverter- parallel Inverter- single phase bridge Inverter – applications of inverters -Cyclo-converter – basic principle of operation- single-phase center tapped Cyclo-converter- applications of Cyclo-converters.

UNIT 5 - Speed Control of DC and AC Motors **Duration: 12 Periods (L: 9 –T: 3)**

Advantages of power electronic drives - DC Motor control - Speed control of DC shunt Motor and DC Series motor by using single phase converters and choppers-Compare chopper controlled drives and converter controlled drives - AC Motor Controls- speed control of 3 phase induction Motor by using AC voltage controllers.

UNIT 6 - Applications of Power Electronic Circuits **Duration: 13Periods (L: 10 –T: 3)**
Applications of power electronic circuits- Types of disturbances in commercial power supply - devices to suppress spikes in supply voltages – SMPS - On line and Off line UPS – advantages - applications – estimation of UPS rating and battery rating for a given load and backup time - Light dimmer Circuit- Burglar alarm Circuit- Emergency lamp Circuit using SCR—power control circuits using SCR – Protecting power devices.

Reference Books

1. Power Electronics– JameelAsghar PHI, New Delhi.
2. Electronics In Industry – George M. Chute & Robert D. Chute
3. Industrial Electronics – G.K.Mithal
4. Power Electronics - P.C.Sen.
5. Industrial Electronics – M.S. Berde
6. Industrial & Power Electronics- Harish Rai.
7. Industrial Electronics and Control - S.K.Bhattacharya&S.Chatterjee
8. Article by R.K.Sugandhi& KK Sugandhi -Thyristor(theory& applications)
9. Power electronics by M.D. Singh &K.B.kanchandani

Suggested E-learning references

1. http://electrical4u.com/
2. www.nptel.ac.in
3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/
4. http://www.eng.uwi.tt/depts/elec/staff/rdefour/ee33d/index.html

OPEN ELECTIVE

ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

Course Code- L:T:P

Introduction:

Welcome to the curriculum for the Artificial Intelligence and Machine Learning (AI&ML) Specialisation. This specialisation course is taught in Bootcamp mode. Bootcamps are 12 weeks, intense learning sessions designed to prepare you for the practical world – ready for either industry or becoming an entrepreneur. You will be assisted through the course, with development-based assessments to enable progressive learning. In this course, you'll learn how to produce a computer- assisted solution when data is too complex for humans to find answers as they combine both data science and machine learning skills that are needed for today's job market.
Some common examples include; Amazon Alexa - converting spoken audio into language; Google Image Search – uses image recognition to return specific search results; Samsung Smart Fridges – uses data and machine learning to produce intuitions about your behavior. Leading to the successful completion of this bootcamp, you shall be equipped to either do an internship at an organization working in AI or do a project in AI. After the completion of your Diploma, you shall be ready to take up roles like Machine Learning Engineer, Data Scientist, Data Analyst, and more.
This course will teach you Fundamentals of AI, Python and Python libraries, data visualization, machine learning models, maths like linear algebra, data interpretation, deep learning, Version control system, cloud deployment and more. Details of the curriculum is presented in the sections below.

Pre-requisite

Before the start of this specialisation course, you would have completed the following courses;

In the 1st year of study, you would have studied Engineering Mathematics, Communication Skills, Computer Aided Engineering Graphics, Statistics & Analysis, Basic IT Skills, Fundamentals of Computer, Fundamentals of Electrical and Electronics Engineering, Project Management skills and Multimedia & Animation.

In the 2nd year of study, you would have studied Python Programming, Computer Hardware, Maintenance and Administration, Computer Networks, Database System Concepts and PL/SQL, Data Structures with Python, Operating System and Administration, Object oriented programming and Design with Java, Software Engineering principles and practices.

In this year of study, you shall be applying your previous years learning along with specialised field of study into projects and real-world applications.

Course outcome: A student should be able to

CO1	**Explain the concept of AI, its applications, constituents and challenges of ethics in AI.**
CO2	**Analyze and visualize any given dataset**

CO3	**Evaluate, optimize, build and test an AI model for a given requirement**
CO4	**Perform comparative analysis of methods or algorithms for a given requirement**
CO5	**Select the appropriate tools, production environment and deploy the model.**

Detailed Course Content

Week	C O	P O	Days	1st session (9am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P
1	1	1	1	1. AI based movie (Screening)			4	- AI influence in companies viz, Amazon, Microsoft, Google, IBM - Latest developments in AI domain - Google's DeepMind AI Just Taught Itself To Walk - YouTube - Introducing Amazon Go and the world's most advanced shopping technology - YouTube - IBM Watson - Understanding the evolution of AI and HMI (human machine interface) - Discussion on how AI will Impact of daily life, work life, work force, jobs, products and services – T	2		1
	1	1	2	Fundamentals of AI - What is artificial intelligence? - How AI works - Purpose of AI - Types of Artificial Intelligence - Goals of AI - Applications of AI	3		1	- Significance of data in AI - AI Software Development life cycle - Compare traditional software development with AI Software Development - Example – Game rules (Chess) Explore and prepare a report on all popular AI cloud services (ML & DL) offered by vendors - T	2		1

				- Ethics in AI Examples of AI in real world - T							
	5	4,5	3	Why Do We Need a Version Control System? Fundamentals of Git Git installation and setup basic local Git operations ▪ creating a repository, ▪ cloning a repository, ▪ making and recording changes ▪ staging and committing changes, ▪ viewing the history of all the changes ▪ undoing changes	1		3	Git Branching and merging Basic ▪ Creating and switching to new branches ▪ Switching between branches ▪ Merging local branches together			3
	5	4,5	4	GitHub - Basics of distributed git - Account creation and configuration - Create and push to repositories - versioning - Collaboration - Migration	1		3	Create repository – named mini project-1 Push the same to GitHub TOC - Git Essentials: Become a Git and GitHub Ninja | Infosys Springboard (onwingspan.com)			3
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	1	**1,5**	6	Real industry experience of AI	2		3	Weekly Assignment(1PM-2PM)			
2	1	1	1	Peer Review		4		**Machine Learning**	2		1

								- Fundamentals - Machine learning types - Machine learning workflow - Machine learning applications - Challenges in ML - Building a model – steps involved - Pipelines ▪ Data engineering ▪ Machine learning ▪ Deployment - What is Data Science? - How Data Science works? - Data Science uses Group discussion - Examples of ML in everyday life / Use of Machine Learning in Daily Life Machine Leaning Terminologies - T TOC - Machine Learning Fundamentals | Infosys Springboard (onwingspan.com) Prediction – continuous value			
	1,5	1,4	2	Introduction to Cloud Computing - Essentials of Cloud Computing - Cloud Deployment Models - Cloud Service Models	2		2	Introduction to Containers Cloud Native application development Explore AI (ML and DL) services across public cloud platforms	1		2

				- Serverless Services - Major Cloud service Providers - Virtualization Explore the cloud service providers and services offered by them - T				Note : teacher has to choose a public cloud platform to perform the fallowing activities - Getting to know cloud platform - Creating an account			
	1,5	**4,5**	3	- Walking through the administrative console and Cloud SDK - Explore Virtual machines (PaaS, Iaas and SaaS) and storage options - Deploy a simple application on the cloud - AI Platform overview	1		3	Essentials of cloud billing SLA TOC - Essentials of Cloud Computing | Infosys Springboard (onwingspan.com) Tutorial - Automatically Create Machine Learning Models - Amazon Web Services Tutorial - Automatically Create Machine Learning Models - Amazon Web Services	1		2
	1	1,3 4	4	Big Data - What is Big Data? - Vs of Big Data - Sources of data - Role of Big Data in AI&ML Python Packages for Machine Learning and Deep Learning - Scientifics computing libraries - Visualization Libraries - Algorithmic libraries Environment setup: install required packages	1		3	Python recap Database connectivity	1		2

				Explore above listed packages							
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	1,5	**2,3 ,4**	6	Build applications using AI cloud services	2		3	Weekly Assignment			
3	**1,5**	**2,3 ,4**	1	Peer review		4		Explore NumPy Module - Array Aggregation Functions - Vectorized Operations - Use Map, Filter, Reduce and Lambda Functions with NumPy - TOC - Pandas and NumPy Tips, Tricks, and Techniques | Infosys Springboard (onwingspan.com)			3
	1,5	**2,3 ,4**	2	Explore Pandas modules - Aggregation and Grouping - Time Series Operations - Pivot and melt function - Use Map, Filter, Reduce and Lambda Functions with Pandas dataframes - TOC - Unpacking NumPy and Pandas | Infosys Springboard (onwingspan.com)	1		3	Contd.			3
	2,5	**2,3 ,4**	3	**Data visualization with python** - Visualization fundamentals - Why visualization	2		2	- Visualizing Amounts - Visualizing distributions			3

				- Coordinate Systems and Axes - Directory of Visualizations Amounts, Distributions, Proportions, x-y Relationships, Uncertainty Basics of python visualization with Matplotlib - Understand the anatomy of a figure - Plot creation - Plotting routines - Basic plot customizations - Saving plots				- Visualizing proportions - Visualizing associations - Visualizing time series **Consider a dataset and infer the relations with the help of different plots.**			
	2,5	2,3, 4	4	- Visualizing trends - Visualizing uncertainty - Visualizing categorical data - visualize proportions - visualize data on multi-plot grid - Composite views for informative summaries of data	1		3	Basics of python visualization with Seaborn The Course Overview - Viewer Page | Infosys Springboard (onwingspan.com)			3
			5	**CIE 1 – Written and Practice Test**				Assessment Review and corrective action			3
	1	4	6	How to create project plan and product backlog for AI project Create Git Repository for following Regression Project - ML / deep learning	2		3	Weekly Assignment			

				Classification Project – ML / deep learning Clustering project – ML / deep learning Natural Language Processing – ML / deep learning							
4	2	**2,3,4**	1	**Peer review** **Mini Project Activity (2)** - **Regression** - **Classification** **(Individual/ Team of 2)** - Define Problem statement (solution to be presented at the semester end) - Create project plan and product backlog - Create git repository for the project - Work progress should be monitored weekly		4		**Data engineering pipeline** **Data Collection** - Population and sample - Types of data ▪ Data type (type 1 (cross sectional, time series), type 2 (univariate, multivariate)) ▪ Variable types (categorical, ordinal, ratio, interval) - Data Collection Key terminologies in Statistics – T **<u>Mini Project Activity</u>** - Data collection for the stated problem	2		1
	2	1,3	2	**Probability** - **Basic concepts** - Conditional and Joint probability - Bayes' Theorem Probability Distributions - Discrete	2		2	**Exploratory data analysis** - overview - EDA goals and benefits **Univariate data analysis** - Characterizing data with descriptive statistics - Univariate distribution plots	1		2

				- Continuous - Central Limit Theorem Infosys Springboard (onwingspan.com) TOC - Probability Distribution using Python | Infosys Springboard (onwingspan.com) **Use relevant python packages to compute Central tendency for the parameters Dispersion for the parameters** **data distribution** **Visualize above computation with various techniques**				- Univariate comparison plots - Univariate composition plots **Mini Project Activity** Data Exploration and analysis for the stated problem			
	2	**2,3 ,4**	3	**Univariate analysis tests** Hypothesis testing Error, Test statistic, type, interpreting test statistics. Understanding p-value	1		3	**Multivariate analysis** Finding relationship in data - Covariance - Correlation	1		2
	2	**2,3 ,4**	4	- Multivariate distribution plot Multivariate comparison plot Multivariate relationship plot Multivariate composition plot			4	**Linear algebra using python** - Scalars - Vectors - Matrices - Tensors Gradients	1		2

				- TOC - Exploratory Data Analysis with Pandas and Python 3.x | Infosys Springboard (onwingspan.com) **Mini Project Activity – Status review** (Data Exploration and analysis for the stated problem)				- **E**igen values and eigen vectors - Norms and Eigen decomposition **Use relevant python packages to perform operations over vectors and matrices.** TOC - Basics of Linear Algebra using Python | Infosys Springboard (onwingspan.com) Interactive Scenario: Introduction to Vector Algebra Using Python (oreilly.com)			
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	2	**2,3 ,4**	6	Statistics and Linear algebra	2		3	Weekly assignment			
5	2,5	**2,3 ,4**	1	Peer review **Mini Project Activity – Status review**		4		**Data Preprocessing** Importance of data preprocessing **Data cleaning** - Assess Data quality - Data anomalies - Detect missing values with pandas dataframe functions: .info() and .isna() - Diagnose type of missing values with visual and statistical methods (eg. chi-squared test of independence) Approaches to deal with missing values ▪ Keep the missing value as is	1		2

								▪ Remove data objects with missing values ▪ Remove the attributes with missing values ▪ Estimate and impute missing values			
	2,5	**2,3 ,4**	2	Practice: Dealing with missing values with different approaches Outliers Detecting outliers ▪ univariate outlier detection ▪ bivariate outlier detection ▪ Time series outlier detection	1		3	Dealing with outliers - Do nothing - Replace with the upper cap or lower cap - Perform a log transformation - Remove data objects with outliers Practice: Dealing with outliers with different approaches TOC - Data Preprocessing | Infosys Springboard (onwingspan.com) TOC - Data Cleaning and Transformation | Infosys Springboard (onwingspan.com)			3
	2,5	**2,3 ,4**	3	Data Integration - Overview - data integration challenges - Approaches - Adding attributes - Adding data objects Practice: data integration	1		3	Data reduction - Distinction between data reduction and data redundancy - Objectives - Methods o numerosity data reduction o dimensionality data reduction	1		2

								Practice: Data reduction with numerosity data reduction method			
	2,5	**2,3 ,4**	4	Data transformation Need for data transformation. - **Normalization** - Standardization Data transformation with - binary coding - ranking transformation - discretization	1		3	Data transformation with - ranking transformation - discretization			3
			5	**CIE 2 – Written and Practice Test**				Assessment Review and corrective action			3
	2,5	**2,3 ,4**	6	**Feature engineering**	2		3	Weekly Assignment			
6	**2,3 ,5**	**2,3 ,4**	1	Peer review **Mini Project Activity – Status review**	4			**Data Splitting** Importance of data splitting - Training set - Validation set - Testing set Underfitting and overfitting Practice : split training and testing data sets in Python using train_test_split() of sci-kit learn. Explore the options of train_test_split()	1		2

	2,3 ,5	**2,3 ,4**	2	**Machine Learning pipeline: Model training** - Supervised Learning: Regression - What is Regression? - Types of regression - Regularization in ML - Real-Life Applications - T - Linear regression Overview Types - simple linear regression - Multiple linear regression - Polynomial linear regression Applications of Linear Regression - T	2		2	Understanding Simple linear regression - Regression equation - Assumptions - Gradient descent - Setting up the regression problem Practice: student score based on study hours Problem statement: • Create a model to analyses the relation between CIE and SEE result • Create a model to analyze the relation between crop yield and rain fall rate Build linear regression model using - Stats model - Scikit learn	1		2
	2,3 ,5	**2,3 ,4**	3	**Model Evaluation & testing** Evaluate regression model: Evaluation Metric - Coefficient of Determination or R-Squared (R2) - Root Mean Squared Error (RSME) - Optimize regression model - Gradient descent	2		2	Cross-validation Why do we need Cross-Validation? Techniques - Hold out method - Leave One Out Cross-Validation - K-Fold Cross-Validation	1		2

	2,3,5	**2,3,4**	4	Multiple Linear Regression - Overview - Assumptions - Normal Equation - Applications Identification and collection of regression dataset - T Perform data exploration, preprocessing and splitting on datasets like - Boston housing price from sci-kit learn datasets - Cricket match result - past data - Performance of a cricket player - past data - Crop yield - past data	2		2	Implementation in python - Build regression model - Evaluate the model - To minimize the cost function			3
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	2,3,5	**2,3,4**	6	**Optimization and performance matrices for regression**	2		3	Weekly Assignment			
7	**2,3,5**	**2,3,4**	1	Peer Review **Mini Project Activity – Status review**		4		Explore other regression algorithms - T Rebuild the model with other regression algorithms such as - Random Forest Regressor - Support Vector Regression - Lasso regression			3

								Evaluate and compare the performance of each.			
	2,3 ,5	**2,3 ,4**	2	Supervised learning – classification What is classification? Types: - Binary classification - Multi-Label Classification - Multi-Class Classification - Imbalanced Classification Classification models Applications - T Practice: Iris dataset from sci-kit learn Perform data exploration, preprocessing and splitting	2		2	Decision trees - What is decision tree? - Understanding Entropy, information gain - How to stop overfitting - Pruning DecisionTreeClassifier - How it works? - Understanding the parameters - Applications	3		
	2,3 ,5	**2,3 ,4**	3	Build decision tree-based model in python for like Breast Cancer Wisconsin (diagnostic) dataset from sci-kit learn Or any classification dataset from UCI , Kaggle			4	Evaluation Metrics for Classification - confusion matrix, - Accuracy - Precision and Recall - Specificity - F1-score - AUC-ROC ▪ How to compute ▪ How does it work	1		2

								▪ When to use			
	2,3,5	**2,3,4**	4	Evaluation Metrics for Classification- contd. Evaluation of decision tree model with different metrics			4	Hyper parameter tuning for DecisionTreeClassifier			3
			5	**CIE 3 – Written and Practice Test**				Assessment Review and corrective action			3
	2,3,5	**2,3,4**	6	Hyper parameter tuning for classification	2		3	Weekly Assignment			
8	**2,3,5**	**2,3,4**	1	Peer review **Mini Project Activity – Status review**		4		Logistic regression - Overview - Types - How does logistic regression work? - Assumptions - Understanding sigmoid function - Applications Practice: build Logistic regression model in python	1		2
	2,3,5	**2,3,4**	2	build Logistic regression model in python Evaluation and optimization of the model	2		2	Support Vector Machine - Introduction to SVM - How does it work? - Applications Practice: Build a SVM Model in python for Fish dataset from Kaggle	2		1
	2,3,5	**2,3,4**	3	Build a SVM Model in python			4	**Ensemble Learning**			3

				How to optimize SVM?				Introduction Basic Ensemble Techniques - Max Voting - Averaging - Weighted Average Advanced Ensemble Techniques - Stacking - Blending - Bagging - Boosting Explore and list the Ensemble Algorithms - T Random Forest - Introduction - How does it work? - Hyper parameters - Applications			
	2,3 ,5	**2,3 ,4**	4	Build Random Forest-based model in python for Breast Cancer Wisconsin (diagnostic) dataset from sci-kit learn Or dataset from UCI , Kaggle			4	Evaluation and optimization			3
			5	**Development Assessment**				Assessment Review and corrective action			3
	2,3 ,5	**2,3 ,4**	6	Comparison of classification algorithms with real world scenario	2		3	Weekly Assignment			

9	3	2,3	1	Peer review **Mini Project Activity – Status review**		4		Unsupervised learning – - What is unsupervised learning? - Common approaches - Challenges - Clustering Types Applications of unsupervised learning - T K-means – Working of K-means How to Choose the Right Number of Clusters?	2		1
	2,3 ,5	**2,3 ,4**	2	**Implementation in python** Evaluation Metrics - Inertia - Dunn Index Evaluate the model using mentioned metrics	1		3	**Contd.**			3
	2,3 ,5	**2,3 ,4**	3	Dimensionality Reduction - Importance of Dimension Reduction in machine learning Common methods to perform Dimension Reduction - T Dimensionality Reduction using PCA in python	2		2	Dimensionality Reduction using PCA in python			3
	5	4,5	4	MLOps - Overview	2		2	- Monitoring - Deployment			3

				- Why MLOps? - ML pipeline - Versioning - Model registry				- Model monitoring			
			5	**CIE 4 – Written and Practice Test**				Assessment Review and corrective action			3
	4	2,3	6	Compare various clustering techniques	2		3	Weekly Assignment			
10	1	3,4	1	Peer review **<u>Mini Project Activity (2)</u>** - Regression - Rebuild with deep learning model - Classification - Rebuild with deep learning model - Analyze the performance of ML and DL **(Individual/ Team of 2)** - Define Problem statement (solution to be presented in the 13th week CIE – 6) - Create project plan and product backlog - Create git repository for the project Work progress should be monitored weekly		4		**Deep learning** - Limitations of Machine Learning - What is deep learning? - Deep learning models - Deep Learning Applications - Deep learning frameworks Group discussion – T Future -Impact deep learning will likely to have on a variety of industries in the next few years. Environment setup - Local - Cloud <u>TOC - Deep Learning with TensorFlow | Infosys Springboard (onwingspan.com)</u>	2		1
	2,3	3,4	2	Introduction to Neural Networks ▪ Understanding	2		2	Introduction to TensorFlow - What is TensorFlow?	1		2

				- Biological Neurons - Artificial neuron /Perceptron - Working of perceptron ▪ Neural network - Architecture - Working of NN - Forward propagation - Back propagation ▪ Activation function - Sigmoid - Tanh - ReLU - LeakyReLU ▪ Cost function - How to measure loss? - How to reduce Loss? - Gradient Descent Get data, and explore Eg. Stroke Prediction Dataset | Kaggle or dataset from any other source Prepare data: Dealing with - missing values - Categorical values				- Why TensorFlow? - TensorFlow ecosystem - TensorFlow architecture - Program Elements in TensorFlow Keras - What is Keras? - Keras APIs – three programming models - Sequential Model - Functional API and - Model Subclassing - Keras layers - Custom Keras Layers TOC - Deep Learning with TensorFlow | Infosys Springboard (onwingspan.com) TOC - TensorFlow for Beginners | Infosys Springboard (onwingspan.com)			

				- Labeled encoding - One hot coding Prepare data : Feature scaling with StandardScalar() or other method Dropping unnecessary features Data splitting Dealing with imbalanced dataset							

	3	2,3, 4	3	- Why do we have to flatten the input data?
				- Understand Keras Dense Layer
				  - Overview
				  - Parameters
				  - Operation
				- Building Shallow Neural Network with Keras Dense Layer
				- Building Deep Neural Network with Keras Dense Layers
				- Create a complete end to end neural network model using Keras Sequential Model and Keras Layer API
				Eg.
				MNIST dataset (classify handwritten numerals) or fashion-MNIST dataset or dataset from other source
					1		3	Keras optimizers
								Keras Metrics
								Keras Losses
								Create a complete end to end neural network – Contd.
								TOC - Learning TensorFlow 2.0 | Infosys Springboard (onwingspan.com)
									1		2

	3	3,4	4	Keras - Callbacks - Commonly used callbacks Monitor neural network performance with TensorBoard - TensorBoard Basics - TensorBoard Setup Understand Model Behavior During Training Reduce overfitting with Dropout Layer	1		3	How to save trained model Local deployment with TensorFlow ModelServer			3
			5	**Development Assessment**				Assessment Review and corrective action			3
	2,3	3,4	6	Building deep learning model with TensorFlow and Keras for use cases	2		3	Weekly Assignment			
11	1,5	2,3, 4	1	Peer Review **Mini Project Activity – Status review**		4		Natural Language Processing Understanding natural language processing NLP approaches – rule based, statistical NLP use cases How to use dictionary? Commonly used NLP tools & libraries Setup environment (spaCy or similar nlp package)	2		1
	2,3	2,3, 4	2	Text processing tasks (Processing Words)	1			Spell Correction	1		2

				Document Assembler Annotation Tokenization - Sentence tokenization - Word tokenization - Visualize frequency distribution of words - Visualize with word cloud Stop word - Dropping stop words - Dropping punctuations			3	Normalization - Stemming - Lemmatization			
	2,3	3	3	Parts of speech tagging Named Entity Recognition	1		3	Vectorizer N-Gram	1		2
	2,3	2.3, 4	4	TF-IDF Build a pipeline for text processing	1		3	Contd.			3
			5	**CIE 5 – Written and Practice Test**				Assessment Review and corrective action			3
	3	2,3	6	NLP – text summarization	2		3	Weekly Assignment			
12	1	2,3, 4	1	Peer review Mini Project Activity – Status review				NLP use case – Sentiment Analysis (SA) What is sentiment analysis? Why is SA important? Business applications for SA How does sentiment analysis work? Transformers	1		2

								Conduct Sentiment analysis to classify movie reviews with - spaCy - TensorFlow and keras			
	1,2, 3,4,	2,3, 4,6	2	NLP use case – Sentiment Analysis (SA) Contd.			4	Ethics in AI - Importance of AI ethics - Ethical challenges of AI - AI code of ethics Group Discussion: Discussion on the Ethics of AI Ethics of AI: Safeguarding Humanity | Professional Education (mit.edu)	1		2
	5	2,3, 4	3	Containers Why containers? What is a docker? How docker works? Components of docker - Docker container - Docker client - Docker daemon - Docker image - Docker registry Install docker on desktop and start the docker tool.	2		2	Publish the container in Registry			3

				TOC - Containers & Images | Infosys Springboard (onwingspan.com) Docker file Docker image Commands to create docker file. Build docker image with docker file create docker container from docker image Run the docker container TOC - Deploying and Running Docker Containers | Infosys Springboard (onwingspan.com) TOC - Docker, Dockerfile, and Docker-Compose (2020 Ready!) | Infosys Springboard (onwingspan.com)							
	5	3,4	4	Deployment strategies	1		3	Contd.			3
			5	**Development Assessment**				Assessment Review and corrective action			3
	1,3	5	6	Using cloud service for MLOps	2		3	Weekly Assignment			

References

Sl. No	Description
1	Hands-On Artificial Intelligence for Beginners By Patrick D. Smith
2	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, By Aurélien Géron
3	Machine Learning with Python for everyone, Mark E Fenner
4	Hands on Data processing in Python , Joy Jafari
5	Deep Learning with TensorFlow2 and Keras , Antonio Gulli, Amita Kapoor,Sujith Pal
6	Cloud Computing, Concepts, Technology and Architecture by Thomas Erl
7	Khan Academy
8	Fundamentals of Data Visualization, Claus O. Wilke
9	Pro Git ,Scott Chacon, Ben Straub
10	Mathematics for Machine Learning, A. Aldo Faisal, Cheng Soon Ong, and Marc Peter Deisenroth
11	Machine Learning, Pipelines, Deployment and MLOps Tutorial | DataCamp
12	MLOps Python Tutorial for Beginners -Get Started with MLOps (projectpro.io)

Cloud Computing and Cyber Security

Under Preparation…….

Internet of Things (IoT)

Pre-requisites-

Knowledge of basic programming skills in python, networking concepts and basic electronic components

Course Outcomes-

Upon completion of the course, the student shall be able to

CO1	**Familiarize with Internet of Things Physical and Logical Design and Levels.**
CO2	**Understand IoT System Management with NETCONF-YANG**
CO3	**Understand Internet of Things, its hardware & software components and applications.**
CO4	**Interpret IoT Application Development**
CO5	**Discuss Security, Privacy and Governance in IoT**
CO6	**Explain IIoT and Case studies for IoT Design**

Course Contents

UNIT - 1: Introduction to Internet of Things

8 Periods

IoT – Definition, characteristics, Physical design of IoT, Things in IoT, IoT Protocols, Logical Design of IoT, IoT functional blocks, IoT communication Models, IoT communication API's IoT enabling Technologies – Wireless sensor networks, Cloud Computing, Big Data Analytics, Communication protocols, embedded systems. IoT Levels and Deployment templates – IoT Level-1, IoT Level-2, IoT Level-3, IoT Level-4, IoT Level-5, IoT Level-6, Popular IoT platforms, Domain specific IoTs

UNIT - 2: M2M, IoT System Management with NETCONF-YANG

6 Periods

M2M, Difference between IoT and M2M, SDN and NFV for IoT, Need for IoT Systems Management, Simple Network Management Protocol, Network Operator requirements, NETCONF, YANG, IoT Systems Management with NETCONG-YANG

UNIT - 3: Elements of IoT

8 Periods

Overview of IoT components-basic building blocks of IoT, Hardware Components- IoT Devices: Raspberry PI, Arduino; Sensors, Actuators, Smart objects and RFID, Software Components-Python Packages of interest for IoT, Networking Protocols

UNIT – 4: IoT Application Development

6 Periods

IoT Design Methodology, Linux on Raspberry PI, Raspberry PI interfaces, Programming Raspberry PI with Python, Data storage on cloud/local server

UNIT - 5: IoT Privacy, Security and Governance

6 Periods

Overview of Governance, Security and Privacy issues, Security, Privacy and Trust in IoT, IoT security life cycle, use of Blockchain in IoT security

UNIT - 6: IIoT and Case Studies on IoT Design

6 Periods

Industrial Internet of Things (IIoT), Differentiate IoT and IIoT, Case Studies-Home Automation, Urban Cities, Environment, Agriculture, Health Care, Transportation.

Reference Books

1. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547
2. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759
3. Dr. SRN Reddy, RachitThukral and Manasi Mishra, “Introduction to Internet of Things: A practical Approach”, ETI Labs
4. Raj Kamal, “Internet of Things: Architecture and Design”, McGraw Hill

Suggested E-learning referencess

1. https://internetofthingsagenda.techtarget.com/
2. https://dzone.com/iot-developer-tutorials-tools-news-reviews
3. https://blog.bosch-si.com/
4. https://www.hackster.io/
5. https://www.libelium.com/
6. https://www.ibm.com/blogs/internet-of-things/
7. https://azure.microsoft.com/en-us/blog/topics/internet-of-things/
8. https://blog.arduino.cc/
9. https://www.raspberrypi.org/blog/
10. www.lemalabs.com/iot

BLOCK CHAIN TECHNOLOGY

OBJECTIVES:

- To understand the concepts of block chain technology
- To understand the consensus and hyper ledger fabric in block chain technology.

OUTCOMES:

- State the basic concepts of block chain
- Paraphrase the list of consensus and Demonstrate and Interpret working of Hyper ledger Fabric
- Implement SDK composer tool and explain the Digital identity for government

UNIT - I

History: Digital Money to Distributed Ledgers -Design Primitives: Protocols, Security, Consensus, Permissions, Privacy- : Block chain Architecture and Design-Basic crypto primitives: Hash, Signature- Hash chain to Block chain-Basic consensus mechanisms.

UNIT - II

Requirements for the consensus protocols-Proof of Work (PoW)-Scalability aspects of Block chain consensus protocols**:** Permissioned Block chains-Design goals-Consensus protocols for Permissioned Block chains.

UNIT - III

Decomposing the consensus process-Hyper ledger fabric components-Chain code Design and Implementation: Hyper ledger Fabric II:-Beyond Chain code: fabric SDK and Front End-Hyper ledger composer tool.

UNIT - IV

Block chain in Financial Software and Systems (FSS): -Settlements, -KYC, -Capital markets-Insurance- Block chain in trade/supply chain: Provenance of goods, visibility, trade/supply chain finance, invoice management/discounting.

UNIT - V

Block chain for Government: Digital identity, land records and other kinds of record keeping between government entities, public distribution system / social welfare systems: Block chain Cryptography: Privacy and Security on Block chain.

TEXT BOOKS:

1. Mark Gates, "*Block chain: Ultimate guide to understanding block chain, bit coin, crypto currencies, smart contracts and the future of money*", Wise Fox Publishing and Mark Gates 2017.
2. Salman Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Anthony O'Dowd, Venkatraman Ramakrishna, "*Hands-On Block chain with Hyper ledger: Building decentralized applications with Hyperledger Fabric and Composer*", 2018.
3. Bahga, Vijay Madisetti, "*Block chain Applications: A Hands-On Approach*", Arshdeep Bahga, Vijay Madisetti publishers 2017.

REFERENCE BOOKS:

1. Andreas Antonopoulos, "*Mastering Bitcoin: Unlocking Digital Crypto currencies*", O'Reilly Media, Inc. 2014.
2. Melanie Swa, "*Block chain* ",O'Reilly Media 2014.

WEB REFERENCES:

- NPTEL & MOOC courses titled blockchain technology
- blockgeeks.comguide/what-is-block-chain-technology
- https://nptel.ac.in/courses/106105184/

DRONE TECHNOLOGY & ROBOTICS

COURSE OBJECTIVES

The course should enable the students to:

1. Learn concepts of Drone and Drone Technology
2. Impart knowledge of AI and Drone technology for various domains applications
3. To make the students to understand the basic concepts of UAV drone systems.
4. To introduce the stability and control of an aircraft

COURSE OUTCOMES

1. Design, build and program simple autonomous robots.
2. Implement standard signal processing and control algorithms.
3. Ability to design UAV drone system
4. To understand working of different types of engines and its area of applications
5. To understand static and dynamic stability dynamic instability and control concepts

UNIT-I- Robotics, Sensors and Signal processing Robotics:

Robotics and AI, Embedded Systems, Agent-Task-Environment model, Embodied Systems, Synthetic approaches to science Sensors and signal processing Common sensors and their properties, 1D signal processing, Vision

UNIT-II- AI and the Internet of Things:
AI and the Internet of Things: Real World Use-Cases: Automated vacuum cleaners, like that of the iRobot Roomba, Smart thermostat solutions, like that of Nest Labs

UNIT-III- Introduction to Drones:
Introduction to Drones: Introduction to Unmanned Aircraft Systems, History of UAV drones, classification of drones, System Composition, applications

UNIT-IV- Design of UAV Drone Systems:
Design of UAV Drone Systems: Introduction to Design and Selection of the System, Aerodynamics and Airframe Configurations, Characteristics of Aircraft Types, Design Standards and Regulatory Aspects-India Specific, Design for Stealth.

UNIT-V- Avionics Hardware of Drones:
Avionics Hardware of Drones: Autopilot, AGL-pressure sensors servos-accelerometer –gyros-actuators- power supply-processor, integration, installation, configuration.

TEXT BOOKS

1. Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010.
2. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc., 1998.

REFERENCE BOOKS

1. The Art of Robotics: An introduction to engineering, F Martin, Addison-Wesley, forthcoming

DATA ANALYTICS

I. RATIONALE

Data Analytics uses statistical and computational methods to analyze data, aiding informed decision-making. Excel dashboards effectively present vital data at a glance, enhancing user interactivity. A Data Analyst collects, cleans, and visualizes Datasets to solve problems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Perform Data Analytics in various business domains for improved decision making

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1 - Elaborate the fundamental concepts of Data Analytics.
CO2 - Apply appropriate statistical techniques to analyze and interpret complex Datasets.
CO3 - Analyze numerical data by creating pivot table.
CO4 - Represent data in terms of various types of charts.
CO5 - Visualize the data using a Python library.

IV. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr. No	Course Content	Hours
1	**Unit - I Introduction to Data Analytics** 1.1 Data Analytics: An Overview, Importance of Data Analytics 1.2 Types of Data Analytics: Descriptive Analysis, Diagnostic Analysis, Predictive Analysis, Prescriptive Analysis, Visual Analytics 1.3 Life cycle of Data Analytics, Quality and Quantity of data, Measurement 1.4 Data Types, Measure of central tendency, Measures of dispersion 1.5 Sampling Funnel, Central Limit Theorem, Confidence Interval, Sampling Variation	
2	**Unit - II Statistical Analysis** 2.1 Graphical techniques, box plot, skewness and kurtosis, Descriptive Stats 2.2 Correlation and Regression, Data Cleaning 2.3 Imputation Techniques 2.4 Anova and Chi Square 2.5 Scatter Diagram 2.6 Estimation and Hypothesis Testing 2.7 Sampling Distributions, Counting 2.8 Probability,Probability Distributions	

3	**Unit - III Data Analytics with Excel** 3.1 Excel Dashboard: Tables and Data Grids, Dynamic Filters and Controls, Trend Analysis and Forecasting 3.2 Pivot Tables: Creating a Pivot Table Specifying Pivot Table Data 3.3 Changing a Pivot Tables, Calculation Filtering and Sorting a Pivot Table 3.4 Creating a Pivot Chart, Grouping Items 3.5 Updating a Pivot Table, formatting a Pivot Table using Slicers	
4	**Unit - IV Data Visualization** 4.1 Creating a Simple Chart, Charting Non-Adjacent Cells 4.2 Creating a Chart Using the Chart Wizard, Modifying Charts, Moving an Embedded Chart, Sizing an Embedded Chart 4.3 Changing the Chart Type, Changing the Way Data is Displayed, Moving the Legend 4.4 Formatting Charts, Adding Chart Items, Formatting All Text, Formatting and Aligning Numbers, Formatting the Plot Area, Formatting Data Markers 4.5 Pie Charts, Creating a Pie Chart Moving the Pie Chart to its Own Sheet Adding Data Labels, Exploding 1.6 a Slice of a Pie Chart	
5	**Unit - V Data Visualization using Python** 5.1 Overview of Matplotlib and its role in data visualization, Installing and setting up Matplotlib in Python 5.2 Basic plotting with Matplotlib, Line plot, Scatter plots, Bar charts, Histograms, adding titles, labels, and legends to plots 5.3 Changing figure size and aspect ratio, Customizing axes (limits, ticks, and labels) 5.4 Exporting and Saving Visualizations: Saving plots in different formats (PNG, PDF, SVG), Adjusting the resolution and quality of saved plots, creating interactive visualizations using Matplotlib widgets	

SUGGESTED LEARNING MATERIALS / BOOKS

Sr. No	**Author**	**Title**	**Publisher with ISBN Number**
1	**Jinjer Simon**	**Excel Data Analysis: Your visual blueprint for analyzing data, charts, and PivotTables**	**Wiley Publication Edition: 3rd ISBN: 978- 0-470-59160-4**
2	**A. J. Smalley**	**Data Analysis with Excel**	**SAGE Publications Edition: 1st, 2007 ISBN 10: 0070139903 / ISBN 13: 9780070139909**
3	**Fabio Nelli**	**Python Data Analytics: With Pandas, NumPy, and Matplotlib**	**Apress pubication ISBN-13 :978-1484239124 ISBN-13978-1484247372**
4	**Jake VanderPlas**	**Python Data Science Handbook**	**Shroff/O'Reilly Publication ISBN-10- 9355422555 ISBN-13-978-9355422552**

5	Business Analytics with MindTap	Jeffrey D. Camm | James J Cochran | Michael J. Fry | Jeffrey W. Ohlmann	Cengage Learning India Pvt. Ltd. Publication Edition:4th ISBN: 9789360533533

V. LEARNING WEBSITES & PORTALS

S.No.	Link / Portal	Description
1	https://spreadsheetpoint.com/excel/dashboard-in-excel/	Advance Excel
2	https://www.javatpoint.com/how-to-create-a-dashboard-in-excel	Excel Dashboard
3	https://www.simplilearn.com/tutorials/excel-tutorial/data-analysis-excel	Data Visualization
4	https://www.freecodecamp.org/news/introduction-to-data-vizualization-using-matplotlib/	Matplotlib in Python
5	https://archive.nptel.ac.in/courses/106/107/106107220/	Introduction to data analytics

PROGRAMMABLE LOGIC CONTROLLERS AND MAT LAB

Course Code- **L:T:P**

Pre requisites

This course requires the knowledge of Digital Electronics and C language commands.

Course Outcomes

CO1	Perform Logical Operations on the PLC.
CO2	Develop the ladder logic program for timer & counter functions, download it to the PLC and run the program
CO3	Execute the ladder programs for PLC based model applications
CO4	Develop and Execute Mathematical expressions and draw Sinusoidal wave in MATLAB environment

Suggested Learning Outcomes

Upon completion of the course, the student shall be able to

C01 – Perform Logical Operations on the PLC

1.1 Identify the main components of the PLC module
1.2 Identify different input devices and output field devices used in Industrial automation
1.3 Perform the simple ON/OFF control task using the PLC.
1.4 Perform a relay switching logic task through a PLC unit
1.5 Develop a ladder logic program for Seal-In-circuit (Latch logic) using PLC, download and run the program.
1.6 Implement latch(Set) and unlatch(Reset) instructions
1.7 Develop a ladder logic program for AND,OR and NOT gates, download the program and run it
1.8 Develop a ladder logic program for NAND,NOR, EX-OR and EX-NOR gates PLC, download the program and run it

C02 - Develop the ladder logic program for timer & counter functions, download it to the PLC and run the program

2.1 Execute the ladder logic program for T-ON(ON-Delay Timer)
2.2 Execute the ladder logic program for T-OFF(OFF-Delay Timer)
2.3 Execute the ladder logic program for RTON(Retentive on)
2.4 Execute the ladder logic program for CTU(count-Up counter)
2.5 Execute the ladder logic program for CTD(count-down Counter)

C03 - Execute the ladder programs for PLC based model applications

3.1 Execute the ladder logic program for stair case lighting
3.2 Execute the ladder logic program for DOL starter
3.3 Execute the ladder logic program for star delta starter

C04 - Practice with MATLAB Environment

4.1 To acquaint with MATLAB windows: Command window, Editor Window, Figure window, Command history window, Current directory window, Workspace window
4.2 Execute a Program to perform below Arithmetic Operators on real numbers
a) Addition b) Subtraction c) Multiplication d) Division
4.3 Develop and execute a Program to Implement below Conditional Statements

a) if-end b) if-else-end c) if-else if-else if-else-end

4.4 Develop and execute a Program to Implement below loop control statements for loop b) while loop
4.5 Develop and execute a program to compute roots of a quadratic equation $ax^2+bx+c=0$ Given a, b and c.
4.6 Develop and Execute a MAT LAB Program to access elements of Array
4.7 Develop and Execute MAT LAB a program to add two Arrays
4.8 Plot a sine wave with title and labels

POWER ELECTRONICS AND POWER SYSTEMS LAB

Course Code- **L:T:P**

Pre requisites

This course requires the knowledge of Power electronics and Power Systems

Course Outcomes

CO1	Analyze various switches in Thyristor family by drawing their characteristics.
CO2	Build Power electronic converters.
CO3	Make use of power electronic converters to control speed of various motors.
CO4	Protect the Power system Equipment

Suggested Learning Outcomes

Upon completion of the course, the student shall be able to

C01 - Analyze various switches in Thyristor family by drawing their characteristics.

1.1 Draw the Static VI characteristics of SCR.
1.2 Draw the Static VI characteristics of IGBT.
1.3 Draw the Static VI characteristics of DIAC.
1.4 Draw the Static VI characteristics of TRIAC.

C02 - Build Power electronic converters.

2.1 Verify the working of Single phase half wave controlled converter with R-load.
2.2 Verify the working of Single phase Full wave fully controlled converter with R-load.
2.3 Invert DC supply to AC supply using Series Inverter.

C03 - Make use of power electronic converters to control speed of various motors.

3.1 Control the speed of DC shunt motor using single phase fully controlled full wave converter.
3.2 Control the speed of DC shunt motor using Chopper.
3.3 Control the speed of 1 Φ induction motor using AC Voltage controller.

C04 - Protect the Power System Equipment

4.1 To study the performance of current and potential Transformers.
4.2 To study the Operation of a Non- Directional electromechanical type over current (I D M T relay) and plot the inverse time current characteristics.
4.3 To study the differential protection scheme for a single phase transformer.