Maharashtra State Board Of Technical Education, Mumbai

Learning and Assessment Scheme for Post S.S.C Diploma Courses

Programme Name	**: Diploma In Automation and Robotics**		
Programme Code	**: AO**	**With Effect From Academic Year**	**: 2023-24**
Duration Of Programme	**: 6 Semester**	**Duration**	**: 12 Weeks (Industry) + 10 Weeks (Institute)**
Semester	**: Fifth** **NCrF Entry Level : 4.0**	**Scheme**	**: K**

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Assessment Scheme												
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week		Paper Duration (hrs.)	Theory				Based on LL & TL				Based on Self Learning		Total Marks
																	Practical						
						CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
													Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
(All Compulsory)																								
1	EMBEDDED SYSTEM	ESY	DSC	315338	-	5	-	2	2	9	3	3	30	70	100	40	25	10	25#	10	25	10	175
2	ML IN ROBOTICS	MIR	DSC	315350	-	5	-	2	2	9	3	3	30	70	100	40	25	10	25@	10	25	10	175
3	ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS	ENDS	AEC	315002	-	1	-	2	-	3	1	-	-	-	-	-	50	20	25@	10	-	-	75
4	SEMINAR AND PROJECT INITIATION COURSE	SPI	AEC	315003	-	-	-	1	2	3	1	-	-	-	-	-	25	10	25@	10	25	10	75
5	INTERNSHIP(12 WEEKS)	ITR	INP	315004	-	-	-	-	-	36 - 40	10	-	-	-	-	-	100	40	100#	40	-	-	200
ELECTIVE (Any - One)																								
6	DIGITAL SIGNAL PROCESSING	DSP	DSE	315343	-	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150
	3D PRINTING	TDP	DSE	315351	-	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150
	INDUSTRIAL PROCESS CONTROL	IPC	DSE	315352	-	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150
Total						**15**		**9**	**6**		**20**		**90**	**210**	**300**		**250**		**225**		**75**		**850**

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Assessment Scheme										
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week		Paper Duration (hrs.)	Theory				Based on LL & TL				Based on Self Learning		Total Marks
																	Practical						
						CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
													Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	

Abbreviations : CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, FA - Formative Assessment,SA -Summative Assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends : @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 10 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities. **Note:** Notional learning hours for **internship represents the student engagement hours.**

Course Category : Discipline Specific Course Core (DSC) , Discipline Specific Elective (DSE) , Value Education Course (VEC) , Intern./Apprenti./Project./Community (INP) , AbilityEnhancement Course (AEC) , Skill Enhancement Course (SEC) , GenericElective (GE)

EMBEDDED SYSTEM **Course Code : 315338**

Programme Name/s	**: Automation and Robotics/ Digital Electronics/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electronics & Communication Engg./ Electronics Engineering/ Industrial Electronics/ Electronics & Computer Engg./**
Programme Code	**: AO/ DE/ EJ/ EK/ ET/ EX/ IE/ TE**
Semester	**: Fifth**
Course Title	**: EMBEDDED SYSTEM**
Course Code	**: 315338**

I. RATIONALE

Embedded systems are designed for specific tasks to excel in real-time performance, resource utilization and reliability. These systems are playing vital role in modern technology, enabling sophisticated functionalities in a wide array of devices and applications. Embedded systems are integral to the advancement of technology across multiple sectors. By learning this course, students will develop skills to use embedded system for simple applications. It will also enable them to use open-source embedded system for solving real time problems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help students to attain the following industry/employer expected outcome through various teaching learning experiences:
"Develop simple applications based on embedded system."

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Select the relevant microcontrollers for various industrial applications.
- CO2 - Choose appropriate family of microcontroller for different applications.
- CO3 - Interpret the communication standards of embedded systems.
- CO4 - Analyze the features of Real Time Operating System.
- CO5 - Develop the basic applications using Arduino.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315338	EMBEDDED SYSTEM	ESY	DSC	5	-	2	2	9	3	3	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 10 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Identify the components of the embedded system and their functions. TLO 1.2 Describe the given characteristic of the specified embedded system. TLO 1.3 Classify the embedded system. TLO 1.4 List the selection factors of the embedded systems.	**Unit - I Overview of Embedded Systems** 1.1 Embedded system, block diagram description, layered model 1.2 Characteristics of embedded system: CPU type, maximum CPU speed, processing power, memory, performance 1.3 Classification of embedded system: small scale, medium scale, sophisticated, stand-alone, reactive/real time (soft and hard real time) 1.4 Selection criteria of embedded system: operating system, reliability, NRE cost, unit cost, size, flexibility, time to prototype, time to market, maintainability, correctness and safety	Lecture using Chalk-Board Presentations
2	TLO 2.1 Compare different types of micro controllers used for embedded system designing. TLO 2.2 Describe AVR microcontroller with the help of block diagram. TLO 2.3 Sketch the block diagram of ATmega 8 and describe the functions of each block. TLO 2.4 Compare specifications of microcontrollers ATmega 8 and ATmega 328. TLO 2.5 List the features of Arduino specific microcontrollers.	**Unit - II Microcontroller Architecture** 2.1 Microcontroller Types: PIC, AVR, ARM, features and applications 2.2 AVR microcontroller: types , architecture 2.3 ATmega 8: features, internal architecture 2.4 Programming configurations of ATmega 8: I/O port, peripherals counter, timer 2.5 Comparison of ATmega 8 and ATmega 328 2.6 Features of Arduino specific AVR microcontroller ATmega 168/328	Presentations Lecture using Chalk-Board Site/Industry Visit

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Describe the given type of modes for communication. TLO 3.2 Describe the given communication protocol(s) with relevant sketches. TLO 3.3 Describe the given wireless serial communication interface. TLO 3.4 Differentiate between given protocols for given parameters.	**Unit - III Communication Standards and Protocols** 3.1 Modes of communication: serial, parallel, synchronous and asynchronous 3.2 Communication Protocols its types: Serial: I2C, CAN, USB 3.3 Serial peripheral interface (SPI), IEC 61850 GOOSE (Protocol for Electric power system applications) 3.4 Wireless protocol : IrDA, Bluetooth, Zigbee, WiFi, LORA, LoWPAN	Lecture using Chalk-Board Presentations
4	TLO 4.1 Describe the functions of the given operating system. TLO 4.2 Compare RTOS and general OS for the given parameters. TLO 4.3 Describe features of RTOS with neat sketch. TLO 4.4 Explain deadlock condition in RTOS with suitable sketch.	**Unit - IV Real Time Operating System** 4.1 Operating system: general and real time operating system 4.2 Characteristics of real time operating system: consistency, reliability, scalability, performance, predictability 4.3 Functions of RTOS, Task management: inter task communication and multitasking, Scheduling: scheduling algorithms, resource allocation and interrupt handling 4.4 Features of RTOS: watchdog timer, semaphore 4.5 Deadlock: reasons of occurrence, handling of deadlock	Lecture using Chalk-Board Flipped Classroom Presentations
5	TLO 5.1 Enlist the different types of Arduino boards and their major features. TLO 5.2 Describe the working of development board using block diagram. TLO 5.3 Describe the given Arduino functions. TLO 5.4 Write steps to interface the given peripheral with Arduino. TLO 5.5 Interface the given sensor with Arduino.	**Unit - V I/O Interfacing with Arduino** 5.1 Arduino Board: introduction, types: Arduino UNO, NANO, MEGA 5.2 Functional Block Diagram of Arduino, pin functions of Arduino 5.3 Functions used in Arduino: math, analog I/O, digital I/O, timer 5.4 Peripheral interfacing with Arduino: keyboard, LCD, seven segment LED, relay, stepper motor, DC motor 5.5 Sensor interfacing with Arduino: temperature sensor, ultrasonic sensor	Lecture using Chalk-Board Presentations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify pins and functions of AVR and PIC microcontroller.	1	*Identification of pins of AVR and PIC Microrontroller	2	CO1 CO2
LLO 2.1 Use an Integrated Development Environment (IDE) tool for developing C Programs of ATmega 168/328.	2	Use an IDE for ATmega 168/328 programming	2	CO2
LLO 3.1 Develop AVR C program to perform addition, subtraction, and multiplication operations on two constant data and output the result to port with some delay between each output.	3	*Write C program to perform various arithematic operations	2	CO2
LLO 4.1 Interface 4 x 4 LED matrix with AVR. LLO 4.2 Develop C program to display various patterns.	4	*Interface LED matrix with AVR microcontroller	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 5.1 Configure USB protocol on PC .	5	Serial Communication using USB	2	CO3
LLO 6.1 Install Arduino IDE and its development tool for Windows/MacOS/Linux operating systems.	6	*Installation of Arduino IDE for Windows/MacOS/Linux operating Systems	2	CO5
LLO 7.1 Build the circuit using 4 switches and 4 LEDs to Arduino Board. LLO 7.2 Test the LED on/off as per switch positions.	7	Building and Testing switch and LED interface using Arduino	2	CO5
LLO 8.1 Develop programs to perform arithmetic operation using math functions: constrain (), max (), min (), Pow(), sq(), sqrt() uisng Arduino.	8	*Programs to perfrom arithematic operations on Arduino	2	CO5
LLO 9.1 Interface two 16 x 2 LCD modules with Arduino using I2C serial communication protocol.	9	*LCD Interfacing to Arduino board	2	CO5
LLO 10.1 Develop program to read the data from the temperature sensor through Arduino and display on LCD.	10	Temperature sensor interfacing to Arduino board	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- List different types of sensors and actuators used with embedded system and also write application of each sensor
- Create a program to control a DC motor using PWM (Pulse Width Modulation).
- Interface a temperature sensor with Arduino and display the readings on the serial monitor
- Develop a simple program to blink an LED using assembly language.
- Implement SPI communication to control an LED matrix display.
- Conduct a market survey for various types of Arduino boards available

Micro project

- Control the position of a servo motor using Arduino
- Control home appliances using Arduino and relays
- Design digital soil moisture meter using Arduino
- Implement a digital clock using an RTC (Real-Time Clock) module
- Create a digital thermometer using arduino and a temperature sensor
- Implement an RFID-based door lock system using Arduino
- Create a simple home automation system to control appliances using an AVR/PIC microcontroller
- Measure distances using an ultrasonic sensor and display the results on an LCD
- Interface any I/O deice to Raspberry pi development board

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Components: AVR, PIC Microcontroller	1
2	PIC Microcontroller: 32.768 KHz and 20 MHz Crystal, On-Board Debugger, USB Powered or externally powered, Adjustable target voltage	1
3	Temperature sensors; range -55 to 125°C	10
4	Simulation softwares: Arduino IDE, Atmel studio, Microchip studio.	3,4,7,8,9,10
5	Microcontroller kit (AVR ATmega 168/328 board and PIC): single board systems with minimum 8K RAM, ROM memory with battery backup, 16 x 4 LCD display, seven segment display, PC keyboard interfacing facility, cross 'C' compiler, USB, interfacing facility with built in power supply.	4
6	Arduino board UNO/ Nano or available microcontroller: ATmega328P, operating voltage: 5V input voltage (recommended): 7-12V input voltage (limit): 6-20V digital I/O pins: 14 (of which 6 provide PWM output) analog input pins: 6 DC current per I/O Pin: 20 mA DC current for 3.3V pin: 50 mA flash memory: 32 KB (ATmega328P) of which 0.5 KB used by bootloader SRAM: 2 KB (ATmega328P) EEPROM: 1 KB (ATmega328P) clock speed: 16 MHz LED bulit in: 13 dimensions: 68.6 mm x 53.4 mm weight: 25 g	6,7,8,9
7	LCD 16x2 Modules	9
8	Desktop PC with mininum RAM 4GB, Windows OS	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Overview of Embedded Systems	CO1	8	4	4	4	12
2	II	Microcontroller Architecture	CO2	12	2	6	8	16
3	III	Communication Standards and Protocols	CO3	8	2	4	8	14
4	IV	Real Time Operating System	CO4	10	4	6	2	12
5	V	I/O Interfacing with Arduino	CO5	12	2	6	8	16
Grand Total				**50**	**14**	**26**	**30**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests of 30 marks and average of two unit test marks will be consider for out of 30 marks.

•For formative assessment of laboratory learning 25 marks.
•Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment is of 70 marks.
- End semester summative assessment is of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	2	2	1	1	-	2			
CO2	3	3	2	2	1	1	2			
CO3	2	2	2	2	1	-	2			
CO4	2	1	2	2	1	1	2			
CO5	3	3	2	3	1	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Raj Kamal	Microcontroller Architecture Programming, Interfacing and System Design	Pearson Education India, Delhi, 2012 ISBN: 978-8131759905
2	Muhamed Ali Mazidi, Sarmad Naimi, Sepehr Naimi	AVR Microcontroller and Embedded Systems: Using Assembly and C	Pearson Education India, Delhi, 2013 ISBN: 978-9332518407
3	Dawoud Shenouda Dawoud, Peter Dawoud	Serial Communication Protocols and Standards	River Publishers, Denmark, 2020 ISBN: 978-8770221542
4	David E. Simon	An Embedded Software Primer	Addison-Wesley, Delhi, 2002 ISBN: 978-9332518407
5	J.M.Hughes	Arduino: A Technical Reference	O'REILLY, 2016 ISBN: 978-1491921760
6	Jeremy Blum	Exploring Arduino Tools and Techniques for Engineering Wizardry	John Wiley & Sons, 2019 ISBN: 978-1118549360
7	Michael McRoberts	Beginning Arduino	APRESS, 2011 ISBN: 978-1430232414
8	K. V. K. K. Prasad	Embedded Real –Time Systems concepts, Design & Programming Black Book	Dreamtech Press New Delhi, 2003 ISBN: 978-8177224610
9	Frank Vahid, Tony Givargis	Embedded System Design A Unified Hardware/ Software Introduction	Wiley India, New Delhi,2006 ISBN: 978-0471386780

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.microchip.com/en-us/tools-resources/develop/microchip-studio	Microchip Studio for AVR® and SAM Devices is an integrated development platform from Microchip
2	http://arduino.cc/	Link for Arduino Related Hardware and Software Download and installation
3	https://learn.sparkfun.com/tutorials/what-is-an-arduino	Arduino Basics
4	https://onlinecourses.swayam2.ac.in/aic20_sp04/preview	Introduction and Concepts of Arduino
5	https://support.arduino.cc/	Tutorials, data sheets, guides and other technical documentation
6	http://vlabs.iitkgp.ac.in/rtes/	Virtual lab link for Microcontrollers
7	https://semiconductors.es/datasheet-pdf/219613/ATMEGA32.html	Datasheet for ATmega Microcontrollers
8	https://www.alldatasheet.com/datasheet-pdf/pdf/82338/MICROCHIP/PIC16F877A.html	Datasheet for PIC Microcontroller

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

ML IN ROBOTICS **Course Code : 315350**

Programme Name/s : **Automation and Robotics**
Programme Code : **AO**
Semester : **Fifth**
Course Title : **ML IN ROBOTICS**
Course Code : **315350**

I. RATIONALE

Machine Learning (ML) is a subfield of artificial intelligence. Machine learning algorithms enable robots to learn from data and adapt to dynamic environments. These algorithms allow robots to identify patterns, make predictions, and improve their performance over time, making them more versatile and effective in a wide range of applications. This course will enable students to apply principles of ML in the field of robotics. This will make students to appreciate how machine learning is used for robotic applications.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help students to attain the following Industry/Employer expected outcome through various teaching learning experiences :
Integrate machine learning with robotics for real-world applications.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Validate a given predictive machine learning model .
- CO2 - Apply supervised machine learning algorithms for solving problems in robotics.
- CO3 - Use unsupervised machine learning for solving practical problems in robotics.
- CO4 - Choose artificial neural network (ANN) for robotic applications.
- CO5 - Apply machine learning in robotics.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315350	ML IN ROBOTICS	MIR	DSC	5	-	2	2	9	3	3	30	70	100	40	25	10	25@	10	25	10	175

Total IKS Hrs for Sem. : Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 10 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 State the need of machine learning in robotics. TLO 1.2 Classify machine learning methods. TLO 1.3 Explain the use of evaluation metrics in machine learning. TLO 1.4 List various cross validation methods in machine learning. TLO 1.5 Describe the concept of deep learning. TLO 1.6 List different types of deep learning.	**Unit - I Basics of Machine Learning** 1.1 Definition of Machine Learning (ML), need of ML 1.2 Classification of machine learning : supervised and unsupervised, semi - supervised and reinforcement 1.3 Evaluation metrics : confusion matrix, accuracy, precision, recall/sensitivity and specificity 1.4 Validation techniques : k-fold cross validation, hyperparameter tuning 1.5 Deep learning : definition, concept and classification of deep learning - artificial neural network, fuzzy logic, expert systems(only enlist, No explanation)	Lecture using Chalk-Board Presentations Hands-on
2	TLO 2.1 Describe supervised learning. TLO 2.2 Differentiate regression and classification. TLO 2.3 Explain the procedure of implementing simple linear regression algorithm. TLO 2.4 Differentiate binary, multiclass and multilabel. TLO 2.5 State key points of logistic regression for classification problems. TLO 2.6 State key points of the decision tree for classification problems. TLO 2.7 Illustrate key points of random forest for classification problems.	**Unit - II Supervised Machine Learning** 2.1 Supervised learning: Definition and categories (regression and classification) 2.2 Regression: implementation of simple linear regression algorithm 2.3 Classification: Binary, Multiclass and Multilabel 2.4 Classification algorithm: K-nearest neighbours, logistic regression, support vector machine, decision tree, random forest (No mathematical derivation, only key points of each algorithm)	Lecture using Chalk-Board Presentations Hands-on
3	TLO 3.1 Explain the features of unsupervised machine learning. TLO 3.2 Differentiate clustering and association unsupervised machine learning methods. TLO 3.3 Illustrate key points of K-means clustering algorithm. TLO 3.4 Explain association rule learning. TLO 3.5 State applications of unsupervised ML method. TLO 3.6 Compare supervised and unsupervised ML methods.	**Unit - III Unsupervised Machine Learning** 3.1 Definition of unsupervised machine learning, types - clustering and association, applications 3.2 Working of unsupervised learning algorithms 3.3 Unsupervised learning algorithms: Types- K-means clustering, hierarchical clustering (Only key points) 3.4 Association rule learning: types-support, confidence and lift, types of algorithms- Apriori algorithm, Eclat algorithm, F-P Growth algorithm (enlist only, no explanation)	Lecture using Chalk-Board Presentations Hands-on Simulation

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Describe the construction of biological neuron with the help of sketch. TLO 4.2 Explain the functioning of biological neural network communication with the help of sketch. TLO 4.3 Describe artificial neural networks(ANN) function with diagram. TLO 4.4 Explain the architecture of single layer feed-forward and multi layer feed-forward neural networks. TLO 4.5 Describe the concept of back-propagation neural networks.	**Unit - IV Overview of Artificial Neural Network** 4.1 Biological neuron: structure and function 4.2 Neural networks: basics of neural networks, artificial neural networks(ANN). unit in neural networks 4.3 ANN structure: artificial neuron structure and functions 4.4 Types of ANN: single layer feed-forward and multi-layer feedforward neural networks 4.5 Back-propagation in neural network: working of forward pass and backward pass(No mathematical derivation)	Lecture using Chalk-Board Presentations Hands-on
5	TLO 5.1 Describe the concept of robotic perception. TLO 5.2 Differentiate Model-based and data-driven robotic systems TLO 5.3 List the applications of ML in robotics. TLO 5.4 Describe working of computer vision using ML. TLO 5.5 Explain the functioning of ML based assistive and medical robots.	**Unit - V Applications of Machine Learning in Robotics** 5.1 Machine learning in robotics: role, concept of robotic perception 5.2 Model-based and data-driven robotic systems 5.3 Case study and Applications of ML in robotics: Computer vision using ML and ANN , ML based pick and place robots , Assistive and medical robots using unsupervised ML	Lecture using Chalk-Board Presentations Video Demonstrations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Write a program to evaluate supervised machine learning model using confusion matrix. LLO 1.2 Analyze the supervised machine learning model using confusion matrix.	1	Implementation of confusion matrix for a given supervised machine learning model	2	CO1
LLO 2.1 Develop a program to evaluate accuracy,precision,sensitivity and specificity for a given predictive ML model .	2	* Implementation of evaluation metrics for a given predictive ML model .	2	CO1
LLO 3.1 Write a program to implement regression type supervised ML.	3	Implementation regression benchmark for a given predictive model.	2	CO2
LLO 4.1 Develop a program using simple Linear regression algorithm for predicting a response using a single feature.	4	* Implementation of simple linear regression algorithm	2	CO2
LLO 5.1 Write a program to implement multiclass classification for iris data set.	5	Implementation of multiclass classification	2	CO2
LLO 6.1 Execute a program to implement support vector machine algorithm for a given data set	6	*Implementation of support vector machine algorithm	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 7.1 Write a program to implement decision tree algorithm for a given supervised ML model OR Write a program to implement random forest algorithm for a given supervised ML model	7	Implementation of decision tree algorithm OR Implementation of random forest algorithm	2	CO2
LLO 8.1 Write a program to implement K-means clustering for a given unsupervised ML model.	8	*Implementation of K-means clustering	2	CO3
LLO 9.1 Execute a python program to implement artificial neural network OR Execute a python program to implement back propagation neural network	9	*Implementation of basic artificial neural network using python OR *Implementation of backpropagation neural network	2	CO4
LLO 10.1 Simulate ML program to pick and place operation in robotics.	10	*Implementation of ML program to pick and place operation in robotics	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Prepare a powerpoint presentation on ML techniques used in robotics
- Prepare the list of various ML techniques used in various types of robots. Also write their specifications.
- Prepare a power point presentation to correlate machine learning work flow with student life
- Prepare a powerpoint presentation based on daily life activities as supervised and unsupervised machine learning.

Micro project

- Case study: House price prediction using unsupervised ML- resources required, Literature review,python program, output
- Develop a program using Machine learning algorithm allows robots to grasp and manipulate objects with precision and dexterity. By analyzing the shape, size, and texture of objects,
- Case study: Any specific disease prediction using supervised ML-Data set collection resources required, Literature review,python program, output

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Computer System (minimum requirement : Processor - 1.5 GHz, RAM - 4GB, Operating System - Windows 7 or above)	All
2	Python Interpreter / IDE	All
3	Python 3.9 or latest version	All
4	Robotics simulation software : RT Toolbox3 / Roboanalyzer or any other simulation software	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Basics of Machine Learning	CO1	10	2	4	4	10
2	II	Supervised Machine Learning	CO2	12	2	8	8	18
3	III	Unsupervised Machine Learning	CO3	10	2	8	8	18
4	IV	Overview of Artificial Neural Network	CO4	12	2	8	6	16
5	V	Applications of Machine Learning in Robotics	CO5	6	2	2	4	8
Grand Total				**50**	**10**	**30**	**30**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- For formative assessment of laboratory learning 25 marks.
- Two offline unit tests of 30 marks and average of two unit test marks will be considered for out of 30 marks.
- Each practical will be assessed considering 60% weightage to process, 40% weightage to product

Summative Assessment (Assessment of Learning)

- End semester assessment is of 70 marks.
- End semester summative assessment is of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	2	1	1	-	-	1			
CO2	2	3	2	2	1	1	2			
CO3	2	3	2	2	1	1	2			
CO4	2	3	2	2	1	1	2			

CO5	2	-	3	3	1	1	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Saroj Kaushik	Artificial Intelligence	CENGAGE Learning. ISBN-13: 978-81-315-1099-5 ISBN-10: 81-315-315-1099-9
2	Munesh Chandra Trivedi	A Classical Approach to Artificial Intelligence	Khanna Book Publishing Co. (P) Ltd. New Delhi 978-81-90698-89-4
3	Monica Bianchini, Milan Simic, Ankush Ghosh, Rabindra Nath Shaw	Machine Learning for Robotics Applications	Springer 978-981-16-0597-0
4	Indranath Chatterjee, Sheetal Zalte	Machine Learning Applications: From Computer Vision to Robotics	Wiley 978-1-394-17334-1
5	Govers, Francis X.	Artificial Intelligence for Robotics: Build intelligent robots that perform human tasks using AI techniques	Packt Publishing Limited ISBN : 978- 1788835442

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://doi.org/10.1007/978-981-16-0598-7	e-book on Machine Learning for Robotics Applications
2	https://www.youtube.com/watch?v=PmxPXYtn1ew	Machine learning applications
3	https://www.youtube.com/watch?v=k64wPf_WSDQ	YouTube Video : The Basics of Robotics Theory: Machine learning applied to robotics
4	https://www.youtube.com/watch?v=4Rl8S7stN5A	Machine learning applications
5	https://onlinecourses.nptel.ac.in/noc23_cs18/preview	Introduction to Machine Learning By Prof. Balaraman Ravindran IIT Madras
6	https://onlinecourses.nptel.ac.in/noc23_ee87/preview	Machine Learning And Deep Learning - Fundamentals And Applications By Prof. M. K. Bhuyan IIT Guwahati
7	https://medium.com/eni-digitalks/machine-learning-for-beginners-with-orange-data-mining-0690372533b9#:~:text=How%20to%20install%20and%20configure,ways%20to%20install%20this%20tool	ML simulator software

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS **Course Code : 315002**

Programme Name/s	**: Artificial Intelligence/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Computer Hardware & Maintenance/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Civil & Environmental Engineering/ Computer Science/ Electronics & Computer Engg.**
Programme Code	**: AI/ AN/ AO/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ HA/ IE/ IF/ IH/ LE/ SE/ TE**
Semester	**: Fifth**
Course Title	**: ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS**
Course Code	**: 315002**

I. RATIONALE

Entrepreneurship and Startups are introduced in this curriculum to develop the entrepreneurial traits among the students before they enter into professional life. Exposing and interacting with entrepreneurship and startup eco-system, students will develop entrepreneurial mind set. The innovative thinking with risk-taking ability along with other traits will be inculcated in the students through micro-projects and training. This exposure will be instrumental in orienting the students in transforming them to become job generators after completion of Diploma in Engineering.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Develop project proposals for launching small scale enterprises and starts up.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Identify one's entrepreneurial traits.
- CO2 - Use information collected from stakeholder for establishing/setting up/founding starts up
- CO3 - Use support systems available for Starts up
- CO4 - Prepare project plans to manage the enterprise effectively

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315002	ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS	ENDS	AEC	1	-	2	-	3	1	-	-	-	-	-	50	20	25@	10	-	-	75

Total IKS Hrs for Sem. : Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 10 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Compare advantages and disadvantages of Entrepreneurship TLO 1.2 Identify entrepreneurial traits through self-analysis TLO 1.3 Compare risk associated with different type of enterprise	**Unit - I Introduction to Entrepreneurship Development** 1.1 Entrepreneurship as a career – charms, advantages, disadvantages , scope- local and global 1.2 Traits of successful entrepreneur: consistency, creativity, initiative, independent decision making, assertiveness, persuasion, persistence, information seeking, handling business communication, commitment to work contract, calculated risk taking, learning from failure 1.3 Types of enterprises and their features : manufacturing, service and trading	Presentations Lecture Using Chalk-Board
2	TLO 2.1 Explain Important factors essential for selection of product/service and selection of process TLO 2.2 Suggest suitable place for setting up the specified enterprise on the basis of given data/circumstances with justification. TLO 2.3 Suggest steps for the selection process of an enterprise for the specified product or service with justification. TLO 2.4 Plan a market study /survey for the specified enterprise	**Unit - II Startup Selection Process** 2.1 Product/Service selection: Process, core competence, product/service life cycle, new product/ service development process, mortality curve, creativity and innovation in product/ service modification / development 2.2 Process selection: Technology life cycle, forms and cost of transformation, factors affecting process selection, location for an industry, material handling. 2.3 Market study procedures: questionnaire design, sampling, market survey, data analysis 2.4 Getting information from concerned stakeholders such as Maharashtra Centre for Entrepreneurship Development[MCED], National Institute for Micro, Small and Medium Enterprises [NI-MSME], Prime Minister Employment Generation Program [PMEGP], Directorate of Industries[DI], Khadi Village Instries Commission[KVIC]	Presentations Lecture Using Chalk-Board

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Explain categorization of MSME on the basis of turnover and investment TLO 3.2 Describe support system provided by central and state government agencies TLO 3.3 State various schemes of government agencies for promotion of entrepreneurship TLO 3.4 Describe help provided by the non governmental agencies for the specified product/service TLO 3.5 Compute breakeven point, ROI and ROS for the specified business enterprise, stating the assumptions made	**Unit - III Support System for Startup** 3.1 Categorization of MSME, ancillary industries 3.2 Support systems- government agencies: MCED, NI MSME, PMEGP,DI, KVIC 3.3 Support agencies for entrepreneurship guidance, training, registration, technical consultation, technology transfer and quality control, marketing and finance. 3.4 Breakeven point, return on investment (ROI) and return on sales (ROS).	Presentations Lecture Using Chalk-Board
4	TLO 4.1 Explain key elements for the given business plan with respect to their purpose/size TLO 4.2 Justify USP of the given product/ service from marketing point of view. TLO 4.3 Formulate business policy for the given product/service. TLO 4.4 Choose relevant negotiation techniques for the given product/ service with justification TLO 4.5 Identify risks that you may encounter for the given type of business/enterprise with justification. TLO 4.6 Describe role of the incubation centre and accelerators for the given product/service.	**Unit - IV Managing Enterprise** 4.1 Techno commercial Feasibility study, feasibility report preparation and evaluation criteria 4.2 Ownership, Capital, Budgeting, Matching entrepreneur with the project 4.3 Unique Selling Proposition [U.S.P.]: Identification, developing a marketing plan. 4.4 Preparing strategies of handling business: policy making, negotiation and bargaining techniques 4.5 Risk Management: Planning for calculated risk taking, initiation with low cost projects, integrated futuristic planning, definition of startup cycle, ecosystem , angel investors, venture capitalist 4.6 Incubation centers and accelerators : Role and procedure	Presentations Lecture Using Chalk-Board

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Collect information of successful entrepreneurial traits	1	*Preparation of report on entrepreneurship as	2	CO1
LLO 2.1 Identify different traits as an entrepreneur from various field LLO 2.2 Suggest different traits from identified problem	2	Case study on ‘Traits of Entrepreneur’	2	CO1
LLO 3.1 Explore probable risks for identified enterprise.	3	*Case study on ‘Risks associated with enterprise	2	CO1
LLO 4.1 Identify new product for development LLO 4.2 Prepare a newly developed product	4	*Preparation of report on ‘Development of new Product	2	CO1 CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 5.1 Identify Process for development of product for new startup	5	Preparation of Report on ' Process selection 'for new startup	2	CO1 CO2 CO3
LLO 6.1 Develop questioner for market survey	6	*Market survey for setting up new Start up	2	CO2 CO3
LLO 7.1 Interpret the use of Technology Life Cycle	7	A Case study on ' Technology life cycle' of any successful entrepreneur.	2	CO3
LLO 8.1 Use information related to support of startups from Government and non-government agencies' LLO 8.2 Prepare report for setting up startup	8	*Preparation of report on 'Information for setting up new startup' from MCED/MSME/KVIC etc	2	CO3 CO4
LLO 9.1 Compute ROI of successful enterprise.	9	Case study on 'Return on Investment (ROI)'of any successful startup	2	CO3
LLO 10.1 Calculate of ROS of any successful enterprise	10	Case study on 'Return on sales (ROS)'of any successful startup	2	CO3
LLO 11.1 Calculate Brake even point of any enterprise	11	Preparation of report on 'Brake even point calculation' of any enterprise.	2	CO3 CO4
LLO 12.1 Prepare feasibility report of given business	12	*Preparation of report on 'feasibility of any Techno-commercial business"	2	CO4
LLO 13.1 Plan a USP of any enterprise.	13	*A case study based on 'Unique selling Proposition (USP) of any successful enterprise	2	CO4
LLO 14.1 Prepare a project report using facilities of Atal Incubation center.	14	*Prepare project report for starting new startup using 'Atal incubation center (AIC)	2	CO1 CO2 CO3 CO4

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Prepare a 'Pitch- desk' for your start up
- Prepare a business plan for a. Market research b. Advertisement agency c. Placement Agency d. Repair and Maintenance agency e. Tour and Travel agency
- Prepare a 'Social entrepreneurship business plan, plan for CSR funding.
- Prepare a ' Women entrepreneurship business plan ' Choose relevant government scheme for the product/service
- Prepare a business plan for identified projects by using entrepreneurial eco system for the same (Schemes, incentives, incubators etc.)

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Computers with internet and printer facility	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to Entrepreneurship Development	CO1	4	0	0	0	0
2	II	Startup Selection Process	CO2	2	0	0	0	0
3	III	Support System for Startup	CO3	2	0	0	0	0
4	IV	Managing Enterprise	CO4	2	0	0	0	0
Grand Total				**10**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Assessment during practicals

Summative Assessment (Assessment of Learning)

- End of term examination

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	2	2	-	-	3	2			
CO2	2	2	2	2	-	3	2			
CO3	2	2	2	2	-	3	2			
CO4	2	2	2	2	-	3	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Dr. Nishith Dubey, Aditya Vyas , Annu Soman , Anupam Singh	Un- boxing Entrepreneurship your self help guide to setup a successful business	Indira Publishing House ISBN 2023,978-93-93577-70-2
2	Gujral, Raman	Reading Material of Entrepreneurship Awareness Camp	Entrepreneurship Development Institute of India (EDI), GOI, 2016 Ahmedabad
3	Chitale, A K	Product Design and Manufacturing	PHI Learning, New Delhi, 2014; ISBN: 9788120348738
4	Charantimath, Poornima	Entrepreneurship Development Small Business Entrepreneurship	Pearson Education India, New Delhi; ISBN: 9788131762264
5	Khanka, S.S.	Entrepreneurship and Small Business Management	S.Chand and Sons, New Delhi, ISBN: 978-93-5161-094-6

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	http://www.mced.nic.in/allproduct.aspx	MCED Product and Plan Details
2	http://niesbud.nic.in/Publication.html	The National Institute for Entrepreneurship and Small Business Development Publications
3	http://niesbud.nic.in/docs/1standardized.pdf	Courses : The National Institute for Entrepreneurship and Small Business Development
4	https://www.nabard.org/Tenders.aspx?cid=501andid=24	NABARD - Information Centre
5	http://www.startupindia.gov.in/pdffile.php?title=Startup%20India%20Action%20Planandtype=Actionandq=Action%20Plan.pdfandc ontent_type=Actionandsubmenupoint=action	Start Up India
6	http://www.ediindia.org/institute.html	About - Entrepreneurship Development Institute of India (EDII)
7	http://www.nstedb.com/training/training.htm	NSTEDB - Training

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

Programme Name/s	**: Automobile Engineering./ Artificial Intelligence/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Computer Hardware & Maintenance/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Production Engineering/ Computer Science/ Electronics & Computer Engg.**
Programme Code	**: AE/ AI/ AN/ AO/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ HA/ IE/ IF/ IH/ LE/ ME/ MK/ PG/ SE/ TE**
Semester	**: Fifth**
Course Title	**: SEMINAR AND PROJECT INITIATION COURSE**
Course Code	**: 315003**

I. RATIONALE

Most of the diploma graduates lack the confidence and fluency while presenting papers or interacting verbally and expressing themselves with a large gathering. Seminar presentation boosts the confidence of the students and prepares them precisely for facing the audience, interviews and group discussions. The course on seminar is to enhance student's ability in the art of academic writing and to present it. It also helps broaden the minds of the participants. Through this course on Seminar, students will develop new ideas and perspectives of the subject /themes of emerging technologies and services of their area of studies. Project initiation enhances project planning skill which establishes measurable objectives and interaction skills.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences: Present a seminar on the selected theme/area of study effectively and confidently to the specific audience and stakeholders. Plan innovative solutions independently or collaboratively to the identified problem statement.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Identify topics of seminar presenting to the large gathering at the institute/conference.
- CO2 - Collect relevant and updated research-based data and information to prepare a paper of seminar presentation.
- CO3 - Apply presentation skills.
- CO4 - Create conducive environment for learning and discussion through seminar presentation.
- CO5 - Identify a problem statement and establish the action plan for the successful completion of the project.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315003	SEMINAR AND PROJECT INITIATION COURSE	SPI	AEC	-	-	1	2	3	1	-	-	-	-	-	25	10	25@	10	25	10	75

V. General guidelines for SEMINAR and Project Initiation

- The seminar must be related to emerging trends in engineering / technology programme or may be inter/ multi-disciplinary, based on the industry expected outcomes of the programme.
- The individual students have different aptitudes and strengths. Therefore, SEMINAR should match the strengths of students. For this purpose, students shall be asked to select the TITLE (Theme)of SEMINAR they would like to prepare and present.
- Seminar titles are to be finalized in consultation with the faculty mentor.
- Seminar must involve logic development of applications of various technologies/ processes applicable in industry.
- Seminar must be assigned to the single student. However, support of other students may be sorted while presenting the seminar
- Students are required to prepare using relevant software tools, write ups for presentation
- Students shall submit One Hard copy and one Soft copy each of the presentation and may be encouraged to keep a recorded copy of the presentation made during the seminar.
- Batch of 3-4 students shall be formed for project initiation.
- Projects give a platform for the students to showcase an attitude of inquiry to identify the problem statement related to the programme. Students shall Identify the information suggesting the cause of the problem and possible solutions

- Students shall study and assess the feasibility of different solutions and the financial implications.
- Students should collect relevant data from different sources (books/internet/market/suppliers/experts through surveys/interviews).
- Students shall prepare required drawings/ designs and detailed plan for the successful execution of the work.
- Students may visit the organisation pertaining to the problem statement as part of initial study.

VI.Guidelines for Seminar preparation and presentation :

Once the title/topic of a seminar has been finalized and allotted to the student, the teacher's role is important as guide, mentor and motivator, to promote learning and sustain the interest of the students.

Following should be kept in mind while preparing and presenting the seminar:

- **Seminar Orientation cum -briefing**: the seminar topics/themes should be innovative, novel and relevant to the curriculum of the programme, and also aligned to the expectations of industry.
- **Seminar Literature surve**y: Information search and data collection: the information and data should be authentic, realistic and relevant to the curriculum of the programme.
- **Seminar Preparation, and presentation**: The seminar shall be present with suitable software tools and supporting handout/notes. The presentation of seminar should not be more than 20 minutes including Q-A session.

The following guidelines may be followed for Project Initiation

- **Establishing project scope:** Determine the boundaries of the project.
- **Defining project objectives:** Set clear and measurable objectives that align with the project's purpose.
- **Stakeholder identification and analysis:** Perform an exercise in identifying all stakeholders involved in the project and analyzing their needs and expectations.
- **Team Formation:** Carefully build a team with the necessary skills and expertise to execute the project successfully.
- **Documentation.** Create a project planner showcasing the action plan, define the project's scope, outline the project definition, and design of the project. The document has to be made available to all stakeholders

VII. Criteria of Assessment /Evaluation of Seminar

A. Formative Assessment (FA) criteria

The assessment of the students in the fifth semester Progressive Assessment (PA) for 50 marks is to be done based on following criteria

A. Suggestive RUBRICS for assessment

Sr. No.	Criteria	Marks
1	Selection Topic/Theme of seminar	05
2	Literature review and data presentation	05
3	Quality of Preparation and innovativeness	05
4	Q-A handling	05
5	Time Management	05
6	Seminar Presentation report	10

Rubrics for assessment of Project Initiation

Sr. No.	Criteria	Marks
1	Selection of Theme of Problem Statement and its innovativeness	05
2	Stages of development of Action plan	05
3	Prototyping	05

The total marks as per above out of 50, shall be converted in proportion of 25 marks.

B. Summative Assessment criteria/

The summative assessment of the students in the fifth semester End-Semester-Examination (ESE) for 50 marks is to be done based on following criteria.
This assessment shall be done by the Faculty.

Suggestive **RUBRICS** may be developed by the faculty

Sr. No.	Criteria	Marks
1	Quality of information/Knowledge presented in SEMINAR	10
2	Creativity, Innovation in SEMINAR presentation	10
3	Response to the question during seminar presentation	10
4	Establishment of Innovative Problem Statement and its presentation	10
5	Objectives of the project and action plan	10

The total obtained marks shall be converted in proportion of 25 marks.

VIII. Suggestive CO-PO Mapping

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	3	1	0	-	2	2	3		
CO-2	2		2	-	2	1	3		
CO-3	3	1	1	2	1	2	3		
CO-4	2	0	0	2	1	2	3		
CO-5	3	3	3	2	2	3	3		

VIII.Typographical instructions/guidelines for seminar preparation & presentation

- The seminar PPT shall be computer typed (English- British)
- Text Font -Times New Roman (TNR), Size-12 point
- Subsection heading TNR- 12 point bold normal
- Section heading TNR- 12 capital bold
- Chapter Name/ Topic Name – TNR- 14 Capital
- All text should be justified. (Settings in the Paragraph)
- Different colors text/diagrams /tables may used
- The name of the candidate, diploma (department), year of submission,name of the institute shall be printed on the first slide of PPT.

IX.Seminar and Project Initiation Report

On completion and presentation of Seminar, every student will submit a brief report which should contain the following:

- Cover Page (as per annexure 1)
- Title page (as per annexure 2)
- Certificate by the Guide (as per annexure 3)
- Acknowledgment (The candidate may thank all those who helped in the execution of the project).
- Abstract of Paper presented in the seminar (It should be in one page and include the purpose of the seminar & methodology if any .)
- Index
- List of Figures
- Introduction
- Literature Review
- Information/Chapters related to Seminar topic
- Advantages and Disadvantages
- Conclusion
- Project Initiation : a) Description of problem statement. b) Scope and objectives. c) State holder d) Platform/ Equipment/ Resource identification.
- Bibliography
- References

NOTE: Seminar report must contain only relevant – technology or platform or OS or tools used and shall not exceed 25-30 pages.

Details of Softcopy to be submitted:

The soft copy of seminar presentation is required to be provided on the back cover of the seminar report in clear packet, which should include the following folders and contents:

1.Presentation (should include a PPT about project in not more than 15 slides)
2.Documentation (should include a word file of the project report)

NOTE: Soft copy must be checked for any harmful viruses before submission.

X. Sample Formats

1) Cover Page - Annexure-I

2) Index - Annexure-II

3) Assessment - Annexure-III

Annexure - I

MSBTE LOGO

SEMINAR Report

Institute Logo

"SEMINAR Title_ _ _ _ _ _ _ _ _ _ _ _ _"

as a partial fulfilment of requirement of the

THIRD YEAR DIPLOMA IN

Submitted by

Name of Student **Enrollment Number**

FOR THE ACADEMIC YEAR 20___20___

(H.O.D) **(Principal)**

(Internal Guide) **(External Examiner)**

Annexure - II

Institute Name

(An Affiliated Institute of Maharashtra State Board of Technical Education)

Table of Contents

INDEX

***Students can add/remove/edit chapter names as per the discussion with their guide**

Annexure - III

Format for SEMINAR and PROJECT INITIATION Assessment /Evaluation

Formative Assessment

CRITERIA AND WEIGHTAGE

Enrollment No	**1** Selection Topic/Theme of seminar (5)	**2** Literature review and data presentation (5)	**3**. Quality of Preparation and innovativeness (5)	**4** Q-A handling (5)	**5** Time Management (5)	6. Seminar Presentation report (10)	**7** Selection of Theme of Problem Statement and its innovativeness (5)	**8** Stages of development of Action plan (5)	**9.** Prototyping (5)	**10.** Total (50)	Scale to (25)

SummativeAssessment

CRITERIA AND WEIGHTAGE

Enrollment No	**1.** Quality of information/Knowledge presented in SEMINAR **10**	**2** Creativity, Innovation in SEMINAR presentation 10	**3**. Response to the question during seminar presentation 10	**4** Establishment of Innovative Problem Statement and its presentation 10	**5** Objectives of the project and action plan 10	Total **(50)**	Scaled to **(25)**

Sign: **Name: ----------** **(Course Expert/s)**	**Sign:** **Name: ----------** **(Program Head)** **(Information Technology)**

Programme Name/s	**: Automobile Engineering./ Artificial Intelligence/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Computer Hardware & Maintenance/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Production Engineering/ Computer Science/ Electronics & Computer Engg.**
Programme Code	**: AE/ AI/ AN/ AO/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ HA/ IE/ IF/ IH/ LE/ ME/ MK/ PG/ SE/ TE**
Semester	**: Fifth**
Course Title	**: INTERNSHIP(12 WEEKS)**
Course Code	**: 315004**

I. RATIONALE

Globalization has prompted organizations to encourage skilled and innovative workforce. Internships are educational and career development opportunities, providing practical/ hands-on experience in a field or discipline. Summer internship is an opportunity for students to get accustomed to modern industry practices, apply the knowledge and skills they've acquired in the classroom to real-world situations and become familiar with industry environments before they enter the professional world. Keeping this in mind, industrial training is incorporated to all diploma programmes as it enables the student to get equipped with practical skills, soft skills and life skills

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences: Apply skills and practices to industrial processes.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Observe time/resource management and industrial safety aspects.
- CO2 - Acquire professional experience of industry environment .
- CO3 - Establish effective communication in working environment.
- CO4 - Prepare report of assigned activities and accomplishments.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											Total Marks
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315004	INTERNSHIP(12 WEEKS)	ITR	INP	-	-	-	-	36 - 40	10	-	-	-	-	-	100	40	100#	40	-	-	200

Legends: # External Assessment
Note: Credits for Industrial Training are in-line of guidelines of NCrF : The industrial training is of 12 weeks considering 36-40 hours per week engagement of students (as per Guidlines of GR of Maharashtra Govt.) under Self Learning with guidance of industry supervisor / Mentor

V General guidelines for organizing Industrial training

The Industry/organization selected for Industrial training/ internships shall be Government/Public Limited/ Private limited / Startup /Centre of Excellence/Skill Centers/Skill Parks etc.

1. Duration of Training - 12 weeks students engagement time
2. Period of Time slot - Between 4th and 5th semester (12 weeks) i.e. commencement of internships will be immediately following the 4th semester exams.
3. Industry area - Engineering Programme Allied industries of large, medium or small-scale, Organization/Govt./ Semi Govt Sectors.

VI Role(s) of Department at the Institute:

Following activities are expected to be performed by the concerned department at the Polytechnics.

Table of activities to be completed for Internship

S.No	Activity	Suggested Schedule WEEKS
1	Collection of information about industry available and ready for extending training with its offered capacity of students (**Sample Format 1**)	1st to 3rd week of 4th Semester
2	Allocations of Student and Mentor as per availability (Mentor: Student Ratio (1:15)	4th to 6th week of 4th semester
3	Communication with Industry and obtaining its confirmation Sample letter Format	6th to 8th week of 4th semester
4	Securing consent letter from parents/guardians of students (Sample Format 2)	Before 10th week of 4th semester
5	Enrollment of Students for industrial training (Format 3)	Before 12th week of 4rd semester
6	Issue of letter to industry for training along with details of students and mentor (Format 4)	Before 14th week of 4th Semester
7	Organize Internship Orientation session for students	Before end of 4th Semester
8	Progressive Assessment of industry training by Mentor	Each week during training period
9	Assessment of training by institutional mentor and Industry mentor	5th Semester ESE

Suggestions-

1. Department can take help of alumina or parents of students having contact in different industries for securing placement.

2. Students would normally be placed as per their choices, in case of more demand for a particular industry, students would be allocated considering their potentials. However preference for placement would be given to students who have arranged placement in company with the help of their parents or relatives.

3. Principal/HOD/Faculty should address students about industrial safety norms, rules and discipline to be maintained in the industry during training before relieving students for training.

4. The faculty members during the visit to industry or sometimes through online mode will check the progress of the student in the training, student attendance, discipline, and project report preparation each week.

VII Roles and Responsibilities of students:

1. Students may interact with the mentor to suggest choices for suitable industry, if any. If students have any contact in industry through their parents or relatives then the same may be utilized for securing placement for themselves and their peers.

2. Students have to fill the forms/formats duly signed by institutional authorities along with a training letter and submit it to a training officer/mentor in the industry on the first day of training.

3. Students must carry with him/her Identity card issued by the institute during the training period.

4. Students should follow industrial dressing protocols, if any. In absence of specific protocol students must wear college uniform compulsorily.

5. Students will have to get all necessary information from the training officer/mentor at industry regarding schedule of training, rules and regulation of the industry and safety norms to be followed. Students are expected to observe these rules, regulations and procedures.

6. Students must be fully aware that if they disobey any rule of industry or do not follow the discipline then non-disciplinary action will be taken .

7. Students must maintain a weekly diary (**Format 6**) by noting daily activities undertaken and get it duly signed from industry mentor or Industrial training in charge.

8. In case students face any major problems in industry such as an accident or any disciplinary issue then they should immediately report the same to the mentor at the institute.

9. Prepare a final report about the training for submitting to the department at the time of presentation and viva-voce and get it signed from a mentor as well as industry training in charge.

10. Students must submit the undertaking as provided in **Format 5**.

VIII Typographical guidelines for Industry Training report

Following is the suggestive format for preparing the training report. Actual report may differ slightly depending upon the nature of industry. The training report may contain the following

1. The training report shall be computer typed (English- British) and printed on A4 size paper.

2. Text Font -Times New Roman (TNR), Size-12 point

3. Subsection heading TNR- 12 point bold normal

4. Section heading TNR- 12 capital bold

5. Chapter Name/ Topic Name – TNR- 14 Capital

6. All text should be justified. (Settings in the Paragraph)

7. The report must be typed on one side only with double space with a margin 3.5 cm on the left, 2.5 cm on the top, and 1.25 cm on the right and at bottom.

8. The training report must be hardbound/ Spiralbound with a cover page in black color. The name of the candidate, diploma (department), year of submission, name of the institute shall be printed on the cover.

9. The training report, the title page should be given first then the Certificate followed by the acknowledgment and then contents with page numbers.

IX Suggestive format of industrial training report

Following format may be used for training report. Actual format may differ slightly depending upon the nature of Industry/ Organization.

- Title Page
- Certificate
- Abstract
- Acknowledgement
- Content Page

Chapter 1	Organization structure of Industry and general layout.
Chapter 2	Introduction to Industry / Organization (history, type of products and services, turn over and number of employees etc.)
Chapter 3	Types of Major Equipments/raw materials/ instruments/machines/ hardware/software used in industry with their specifications, approximate cost, specific use and routine maintenance done
Chapter 4	Processes/ Manufacturing Manufacturing techniques and methodologies and material handling procedures
Chapter 5	Testing of Hardware/Software/ Raw materials/ Major material handling product (lifts, cranes, slings, pulleys, jacks, conveyor belts etc.) and material handling procedures.
Chapter 6	Safety procedures followed and safety gears used by industry.
Chapter 7	Particulars of Practical Experiences in Industry/Organization if any in Production/Assembly/Testing/Maintenance
Chapter 8	Detailed report of the tasks undertaken (during the training).
Chapter 9	Special/challenging experiences encountered during training if any (may include students liking & disliking of workplaces).
Chapter 10	Conclusion
Chapter 11	References / sources of information

X Suggested learning strategies during training at Industry

- Students should visit the website of the industry where they are undergoing training to collect information about products, processes, capacity, number of employees, turnover etc.
- They should also refer to the handbook of the major machines and operations, testing, quality control and testing manuals.
- Students may also visit websites related to other industries wherein similar products are being manufactured.

XI Tentative week wise schedule of Industry Training

Industrial training is a common course to all Diploma programmes , therefore the industry selection will depend upon the nature of the programme and its related industry. The training activity may vary according to nature and size of industry.

The following table details of activities to be completed during industrial training.

Details of Activities to be completed during Industry training
Introduction of Industry and departments.
Study of Layout of Industry, Specifications of Machines , raw materials, components available in the industry

Study of setup and manufacturing processes
Execute given project or work assigned to the students, study of safety and maintenance procedures
Validation from industry mentor regarding project or work allocated
Report writing

XII CO-PO Mapping Table to be created by respective Department/faculty.

XIII. Formative Assessment of training : Suggested RUBRIC
(Note : Allot the marks in proportion of presentations and outcome observed. Marks excluding component of week 11 are to be filled by Institute mentor)

Week No	Task to be assessed	Outcome Achievement - Poor	Outcome Achievement - Moderate	Outcome Achievement - High		Week-wise total Marks
		Poor Marks	Average Marks	Good Marks	Excellent Marks	
1	Introduction of Industry	Minimal Knowledge of Departments, processes, products and work culture of the company **(Marks –1)**	Moderate Knowledge of Departments, processes, products and work culture of the company **(Marks –2)**	Good Knowledge of Departments, processes, products and work culture of the company **(Marks –3/4)**	Extensive Knowledge of Departments, processes, products and work culture of the company **(Marks –5)**	
2	Presentation of Layout of Industry, Specifications of Machines, raw materials, components available in the industry	Minimal w.r.t. tasks **(Marks –1)**	Moderate w.r.t. tasks **(Marks –2)**	Good w.r.t. tasks **(Marks –3/4)**	Extensive w.r.t. tasks **(Marks –5)**	
3	Participation in setup and manufacturing processes/platforms	Minimal Participation with poor understanding **(Marks –1-8)**	Moderate Participation with poor understanding **(Marks –9-12)**	Good Participation with poor understanding **(Marks –13-17)**	Extensive Participation with poor understanding **(Marks –18-20)**	
4 to 10	Execution of given project or work to the students, Follow of safety and maintenance procedures	Minimal Participation with poor understanding **(Marks –1-8)**	Moderate Participation with lower level understanding **(Marks – 9-12)**	Good Participation with Good understanding **(Marks – 13-17)**	Extensive Participation with excellent understanding **(Marks – 18-20)**	
11	Validation by industry mentor regarding project or work allocated	Minimal Participation with poor performance **(Marks –1-10)**	Moderate Participation with acceptable performance **(Marks – 11-15)**	Good Participation with Good performance **(Marks – 16-20)**	Extensive Participation with excellent performance **(Marks – 21-25)**	

12	Diary writing	• Results are not Presented properly, • Project work is summarized and concluded not acceptable • Future extensions are not specified **(Marks –1-10)**	• Results are Presented just casually • Project work is summarized and concluded casually • Future extensions are casually specified **(Marks –11-15)**	• Results are Presented well and properly, • Project work is summarized and concluded to a Good level • Future extensions are well specified **(Marks –16-20)**	• Results are Presented exhaustively • Project work is summarized and elaborated in excellent manner , concluded • Future extensions are excellently specified **(Marks –21-25)**	
Total Out of :100						

Marks for (FA) are to be awarded for each week considering the level of completeness of activity observed as per table specified in Sr.No. XIII above, from the daily diary maintained . Feedback from industry supervisor shall also be considered.

XIV Summative Assessment (SA) of training:

Academic year : 20 -20

i) Suggested RUBRIC for SA

Enrollment Number	**Observations from Orals**				**Presentations**				**Total (100)**
	Tasks undertaken (20)	Overall Understanding (20)	Creativity /Innovation demonstrated (10)	Knowledge acquired (10)	Speech Clarity (10)	Body Language (10)	Presentations (10)	Diary , Report writing and / Product (10)	

Name of mentor:
Signature of Mentor

XV FORMATS

Format-1: Collecting Information about Industry/Organization available for training along with capacity

1) Name of the industry/organization:
2) Address/communication details with email :
3) Contact person details:
   a) Name:
   b) Designation:
   c) Email
   d) Contact number/s:

4) Type:

   Govt / PSU / Pvt /

   Large scale / Medium scale / Small scale …..

5) Products/services offered by industry:

6) a) Whether willing to offer Industrial training facility during May/ June for Diploma in Engineering students: **Yes / No.**
   b) If yes, whether you offer 12 weeks training: **Yes/No**
   c) Possible Industrial Capacity:

Students	Programme name/ Title					Total
	Civil	Mechanical	Chemical			
Male						
Female						
Total						

7) Whether accommodation available for interns **Yes / No.**
If yes capacity:_____

8) Whether internship is charged or free:
If charged please specify amount per candidate: _____

Signature of responsible person at Industry:

Format-2: Obtaining Consent Letter from parents/guardians

(Undertaking from Parents)

To,

The Principal,
_____,

Subject: Consent for Industrial Training.
Sir/Madam,

I am fully aware that -
i) My ward studying in _____ semester at your _____ institute has to undergo 12 weeks of Industrial training for partial fulfillment towards completion of Diploma in _____ Engineering.
ii) For this fulfillment he/she has been deputed at_____ industry, located at _____ for Industrial training /internship for the period from _____ to _____ .
With respect to above I give my full consent for my ward to travel to and from the mentioned industry. Further I undertake that –
a) My ward will undergo the training at his/her own cost and risk during training and/or stay.
b) My ward will be entirely under the discipline of the organization where he/she will be placed and will abide by the rules and regulations in face of the said organization.
c) My ward is NOT entitled to any leave during the training period.
d) My ward will regularly submit a prescribed weekly diary, duly filled and countersigned by the training supervisor of the organization to the mentor faculty of the polytechnic.

I have explained the contents of the letter to my ward, who has also promised to adhere strictly to the requirements. I assure that my ward will be properly instructed to take his own care to avoid any accidents/injuries in the industry. In case of any accident neither industry nor the institute will be held responsible.

Signature :
Name : _____
Address : _____

Phone Number :

Format-3: Students Enrollment for Industrial Training

(Academic Year –)

Sr No	Enrollment Number	Name of Student	Name of Industry	Name of Mentor at Institute

Format-4: Issue Letter to the Industry/Organization for the training along with details of students and mentors

To,

The HR Manager,

_____

Subject: Placement for Industrial training of ___ weeks in your organization….

Reference: Your consent letter no: ….

Sir,

With reference to the above we are honored to place the following students from this institute for Industrial training in your esteemed organization as per the arrangement arrived at.

The purpose of this training is to equip the student with some essential skills relevant to the demands of the industry and world of work, as well as to provide exposure to the professional environment and work culture. It is hoped that this training may enhance his/her employability and livelihood opportunities. In view of the above, we kindly request your support in facilitating this Industrial Training for the student. He/she has been adequately oriented and guided on the expectations of this training, including the maintenance of a daily diary during the training period. Additionally, the institute has secured the necessary consent and undertaking from the parent/guardian regarding the guidelines for exit training. In view of all the above industry shall refrain from involving students into the mundane and housekeeping activities. Your cooperation in this regard will be highly appreciated.

Diploma programme in _____ Engg.

Sr.No	Enrollment No	Name of Student	Name and designation of Mentor

Diploma programme in _____ Engg.

Sr.No	Enrollment No	Name of Student	Name and Designation of Mentor

Kindly extend all possible cooperation to the students for above.

Thanking you

Yours sincerely,

(Principal)
Name of the Institute:
with Seal

Cc- To HoD/Mentor

Format-5: Undertaking by the students

TO

Principal

Subject: Undertaking regarding Placement for Industrial training of 12/16/18 weeks duration

I …….Reg No:…….. S/o/D/o. ……Studying in ---------- ---------- at ---------- Institute at ----------fully aware of the Industrial Training requirement and related responsibilities and participation in the ……, Industrial training between From: …… To……..

I assure you that I will be of good behavior and be obedient to the staff and mentor during the ……/Industrial training. I will also abide and will not participate in all activity. I will also discipline myself within the rules and regulations of the Institution. I am also aware that I am participating in the …….. at my own risk and I will not hold the ----------Institute responsible in any way in any eventuality namely Accident /Injury/death or whatever mishap and I myself will be solely responsible for my safety.

Place :Signature of the student

Date :Reg. No.

Format-6: Internships Daily Diary

Name of the Student: _____ Name of the mentor (Faculty) : _____

Enrollment Number: _____ Semester: _____ Academic Year _____

Week	Day & Date	Discussion Topics/Activity	Details of Work Allotted Till Next Session /Corrections Suggested/Faculty Remarks	Signature of Industry Mentor
Week 01	Mon, Date			
	Tue, Date			
	Wed, Date			
	Thu, Date			
	Fri, Date			
	Sat, Date			
.	Mon, Date			
	Tue, Date			
.	Wed, Date			
	Thu, Date			
.	Fri, Date			
	Sat, Date			
Week n	Mon, Date			
	Tue, Date			
	Wed, Date			
	Thu, Date			
	Fri, Date			
	Sat, Date			

DIGITAL SIGNAL PROCESSING **Course Code : 315343**

Programme Name/s : **Automation and Robotics/ Digital Electronics**
Programme Code : **AO/ DE**
Semester : **Fifth**
Course Title : **DIGITAL SIGNAL PROCESSING**
Course Code : **315343**

I. RATIONALE

Digital Signal Processing plays an increasingly important role in almost every field of electronics and automation engineering that includes applications such as speech recognition, echo cancellation, image enhancement, geographical exploration, medical imaging etc. This course aims to build concepts related to the fundamental principles and applications of signals, systems, transform and filters, to develop skills to use basic DSP tools like Z-transform, Fourier transform, DFT, FFT etc.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help students to attain the following industry/employer expected outcome through various teaching learning experiences:
"Use DSP tools for signal processing."

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Identify different types of signals and systems.
- CO2 - Evaluate the signals using Fourier transform.
- CO3 - Interpret the stability of signal/system using Z-transform.
- CO4 - Apply DFT to analyse digital signals and systems.
- CO5 - Interpret working of DSP processor based real world applications.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315343	DIGITAL SIGNAL PROCESSING	DSP	DSE	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 10 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the basic elements of digital signal processing system. TLO 1.2 Classify different types of signals. TLO 1.3 Sketch the given standard input signals. TLO 1.4 Differentiate between time invariant and time variant system with example. TLO 1.5 State sampling theorem and its use in DSP.	**Unit - I Signals and Systems** 1.1 Basics of signals and signal processing: Classification of signals-digital and discrete signals, continuous and discrete signals, energy and power signals, periodic and non-periodic signals, even and odd signals, deterministic and random signals, simple numericals, basic elements and applications of digital signal processing, digital and analog signal processing 1.2 Standard test signals:Types of test signals, unit impulse, unit step, unit ramp, exponential, sinusoidal signals 1.3 Basic operations on signals such as addition, subtraction, multiplication, scaling, inversion 1.4 Basics and classification of systems: Static and dynamic system, causal and non-causal system, time invariant and time variant system, linear and nonlinear system, invertible and non-invertible system, stable and unstable system, simple numericals 1.5 Sampling: Sampling theorem, Nyquist rate, aliasing	Lecture using Chalk-Board Video demonstrations Collaborative learning Presentations
2	TLO 2.1 Write the expression for Fourier series for the given signal/sequence. TLO 2.2 Describe the properties of Fourier transform. TLO 2.3 Explain frequency domain analysis of LTI system. TLO 2.4 Calculate the response of LTI system for the given exponential signal.	**Unit - II Fourier Series Transform** 2.1 Fourier series representation for the periodic signal: Trigonometric and exponential form, simple numericals 2.2 Fourier transform: Properties, Fourier transform for continuous and discrete time aperiodic signal, simple numericals 2.3 Frequency domain analysis of Linear time invariant (LTI) system 2.4 Response of LTI system for the complex, exponential and sinusoidal signal	Lecture using Chalk-Board Video Demonstrations Collaborative learning Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Establish the relation between Z-transform and Fourier transform. TLO 3.2 Describe the properties of Z-transform. TLO 3.3 Explain the significance of ROC to determine system stability. TLO 3.4 Illustrate the procedure to find the stability of any given function using Z-transform.	**Unit - III Z -Transform** 3.1 Relation between Z-transform and Fourier transform, definition, region of convergence (ROC) 3.2 Properties of Z-transform, applications, inverse Z-transform 3.3 Transform of s-plane into Z-plane, stability of discrete time system in Z-domain/plane 3.4 Stability determination using Z-transform	Lecture using Chalk-Board Collaborative learning Video demonstrations Presentations
4	TLO 4.1 Explain the properties of DFT. TLO 4.2 Compute DFT for the given signal. TLO 4.3 Explain the procedure to calculate circular convolution with one example. TLO 4.4 Explain the advantages of FFT over DFT.	**Unit - IV DFT and FFT** 4.1 Discrete Fourier transform (DFT): Definition, properties, multiplication of two DFT sequences 4.2 Linear convolutions of finite duration sequences, circular convolution, effective computation of DFT, 2 and 4 point radix algorithm, numericals 4.3 Fast Fourier Transform: Definition and methods 4.4 Advantages of FFT over DFT	Lecture using Chalk-Board Video Demonstrations Presentations Industry Expert Lecture
5	TLO 5.1 Differentiate between FIR and IIR filters. TLO 5.2 Sketch the internal architecture of the given DSP processor. TLO 5.3 Describe the features of DSP processor TMS320C665x. TLO 5.4 Describe any one application of DSP processor with the help of labeled block diagram.	**Unit - V DSP Filters and Processor** 5.1 Digital filters: Need of digital filters, Finite impulse response (FIR) and Infinite impulse response (IIR) filters, their features 5.2 Internal architecture of DSP processor, pipeline, barrel shifter, multiplier-accumulator (MAC) hardware 5.3 Features of DSP processor, architectures of fixed and floating point DSP processor (TMS320C665x) 5.4 Applications of DSP processor: Tone generation, ECG/EEG signal generation, speech synthesis, echo cancellation, RADAR signal processing (Block schematic approach)	Lecture Using Chalk-Board Video demonstrations Expert lecture Cooperative Learning

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Generate different test signals using Scilab/Matlab or any suitable software. LLO 1.2 Display the signals.	1	Use Scilab/Matlab or any suitable software to perform the mentioned laboratory based problems in this course. * Generation of standard test signals	2	CO1
LLO 2.1 Calculate the sampling frequency for the given input signal. LLO 2.2 Interpret the effect of over and under sampling.	2	* Verification of sampling theorm and effect of under sampling (aliasing)	2	CO1

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 3.1 Use suitable software to analyse the output of LTI system for the given input.	3	Evaluation of linear time invariant system for the given test input signal	2	CO1
LLO 4.1 Compute Fourier transform of standard test signal.	4	* Computation of Fourier transform of standard signal	2	CO2
LLO 5.1 Compute Z transform of given function	5	Computation of Z-transform of the given sequence	2	CO2
LLO 6.1 Compute the Z-transform of the given sequence. LLO 6.2 Plot the ROC of the given sequence.	6	* Analyse the properties of discrete time system using Z-transform	2	CO3
LLO 7.1 Compute Discrete Fourier Transform (DFT) for the given sequence. LLO 7.2 Plot the magnitude and phase spectrum.	7	Computation of N point DFT of a given sequence	2	CO4
LLO 8.1 Compute linear and circular convolution of N number sequence. LLO 8.2 Develope a code to find convolution of two given sequence.	8	* Implementation of a code for linear and circular convolution of finite duration sequence	2	CO4
LLO 9.1 Identify various hardware sections of given DSP processor.	9	Identification of different parts of DSP processor	2	CO5
LLO 10.1 Generate and recognize the basic musical audio tones. LLO 10.2 Measure the corresponding frequencies.	10	* Generation of musical audio tones: "Sa Sa Re Re Ga Ga Ma Ma"	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Not Applicable

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	DSP processor hardware TMS320C665x - I2C, UART, Multichannel Buffered Serial Port (McBSP), Universal Parallel Port (uPP), and a 16-bit asynchronous EMIF along with general-purpose CMOS IO (or any equivalent DSP processor)	9
2	Scilab (Open source software)	All
3	MATLAB or any other suitable software	All
4	Desktop Computers/Laptops (with suitable configuration)	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Signals and Systems	CO1	6	2	6	4	12
2	II	Fourier Series Transform	CO2	10	6	4	6	16
3	III	Z -Transform	CO3	10	4	4	8	16
4	IV	DFT and FFT	CO4	8	4	4	6	14
5	V	DSP Filters and Processor	CO5	6	2	4	6	12
Grand Total				**40**	**18**	**22**	**30**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests of 30 marks and average of two -unit test marks will be considered for out of 30 marks .For formative assessment of laboratory learning 25 marks.Each practical will be assessed consider 60 % weightage to process , 40 % weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks. End semester summative assessment of 25 marks for laboratory learning

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	3	1	2	1	-	2			
CO2	2	2	1	2	1	1	1			
CO3	2	2	1	2	1	1	1			
CO4	2	2	1	2	2	1	1			
CO5	2	2	2	2	2	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Tarun Kumar Rawat	Digital Signal Processing	Oxford University Press ISBN :978-0198081937
2	S. K. Mitra	Digital Signal Processing	TMH ISBN:978-0071157933
3	John G. Proakis, Dimitris G.Manolakis	Digital Signal Processing	PHI ISBN:978-8131710005
4	Oppenheim A., Schafer R., Buck J.	Discrete Time Signal Processing	Pearson Education ISBN: 978-0131988422
5	S. Salivahan, C. Gnanapriya	Digital Signal Processing	Mc Graw Hill Education (India) ISBN: 978-9353167424

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://nptel.ac.in/courses/108104100	Principles of Signals and Systems
2	https://ocw.mit.edu/courses/res-6-007-signals-and-systems-spring-2011/pages/lecture-notes/	DSP Lecture Notes
3	https://www.iitg.ac.in/cseweb/vlab/Signal-System-Lab/signalsystem/Signals%20and%20their%20properties(simulator).html	Signals and Systems and their Properties
4	http://vlabs.iitkgp.ac.in/dsp/#	DSP Virtual Laboratory
5	https://nptel.ac.in/courses/108/101/108101174/	Course: Digital Signal Processing - IIT Bombay
6	https://www.youtube.com/playlist?list=PL4FA894BD6A9586E1	Course: Digital Signal Processing - IIT Kharagpur

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

3D PRINTING **Course Code : 315351**

Programme Name/s : **Automation and Robotics**
Programme Code : **AO**
Semester : **Fifth**
Course Title : **3D PRINTING**
Course Code : **315351**

I. RATIONALE

3D printing is a versatile and rapidly evolving technology essential for modern manufacturing, prototyping, and product development. Acquiring skills in 3D printing principles, technologies, and practical techniques ensures that students are prepared to handle various applications, select appropriate materials, and execute effective post-processing. By developing these skills, students will be well-equipped to meet industry demands, contribute to innovative projects, and solve complex challenges in manufacturing of various components required for industrial automation and robotics designs.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help students to attain the following industry/employer expected outcome through various teaching and learning experiences-
Apply the knowledge of 3D printing technology for manufacturing tailor-made objects required for robotics, healthcare, automotive, entertainment, consumer goods, and in similar applications.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Compare conventional and additive manufacturing processes.
- CO2 - Differentiate between various additive manufacturing processes.
- CO3 - Apply techniques to obtain and slice 3D models.
- CO4 - Select appropriate materials for 3D printing based on desired properties.
- CO5 - Implement post-processing techniques in 3D printing.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315351	3D PRINTING	TDP	DSE	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150

Total IKS Hrs for Sem. : Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 10 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain the principle of 3D printing. TLO 1.2 Differentiate between conventional manufacturing and additive manufacturing processes. TLO 1.3 Describe the advantages, disadvantages, and industrial applications of 3D printing.	**Unit - I Basics of 3D Printing** 1.1 Basic principle of 3D printing, steps in 3D printing process 1.2 Conventional v/s Additive manufacturing processes 1.3 3D printer components and its calibration 1.4 Advantages and disadvantages of the 3D printing process 1.5 Industrial applications of 3D printing	Lecture Using Chalk-Board Model Demonstration Presentations Video Demonstrations
2	TLO 2.1 Describe various additive manufacturing processes. TLO 2.2 Select appropriate process parameters for various additive manufacturing techniques. TLO 2.3 Explain the governing bonding mechanisms in different 3D printing technologies.	**Unit - II Additive Manufacturing Techniques** 2.1 Classification of additive manufacturing processes 2.2 Stereo- lithography, laminated object manufacturing, fused deposition modeling, selective laser sintering, selective laser melting, binder jet technology 2.3 Process selection for various applications 2.4 Governing bonding mechanism in 3D printing	Lecture Using Chalk-Board Presentations Video Demonstrations Site/Industry Visit
3	TLO 3.1 Explain different methods to obtain 3D models. TLO 3.2 Explain various CAD data formats. TLO 3.3 State data translation, data loss & STL format. TLO 3.4 Describe the given method to implement communication between software and 3D printer.	**Unit - III Model Preparation and Data Transfer** 3.1 Different methods to obtain 3D models 3.2 Data exchange formats 3.3 Common slicing softwares 3.4 Common basic slicer settings (layer height, fill density, supports, platform adhesion – skirt, brim, raft, shell thickness) 3.5 Data translation, data loss 3.6 Transferring data from software to printer through: USB, SD card, dedicated controller, Wi-Fi, cloud based	Lecture Using Chalk-Board Presentations Demonstration

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Describe the criteria for selecting materials in 3D printing. TLO 4.2 Explain the properties of polymers, metals, non-metals, and ceramics. TLO 4.3 Explain the features of support materials in 3D printing. TLO 4.4 State the need and applications of hybrid materials used in 3D printing.	**Unit - IV Materials used for 3D Printing** 4.1 Material selection criteria 4.2 Polymers, metals, non-metals, ceramics 4.3 Various forms of raw material- liquid, solid, wire, powder, powder preparation and their desired properties 4.4 Support materials used in 3D printing: Properties & applications 4.5 Hybrid materials : Carbon fiber reinforced filaments, metal-polymer composites, wood-infused filaments, conductive filaments, magnetic filaments	Lecture Using Chalk-Board Collaborative learning Presentations Video Demonstrations
5	TLO 5.1 Explain post-processing techniques used in 3D printing. TLO 5.2 Identify various tools involved for inspection and testing. TLO 5.3 Explain the defects and their causes in 3D printed objects. TLO 5.4 Explain troubleshooting methods in 3D printing.	**Unit - V Post-processing Techniques in 3D Printing** 5.1 Post-processing techniques, need of post-processing, steps in post processing 5.2 Post-processing techniques: Support material removal, surface texture improvements, accuracy improvements, aesthetic improvements 5.3 Inspection and testing of 3D printed objects 5.4 Defects and their causes in 3D printed objects 5.5 Common faults and troubleshooting 3D printer	Lecture Using Chalk-Board Video Demonstrations Model Demonstration

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Calibrate the 3D printer bed level for optimal first layer adhesion and print quality. LLO 1.2 Verify temperature settings and filament flow rate to maintain consistent extrusion.	1	*Calibration of 3D printer-bed level, temperature calibration, filament flow rate calibration	2	CO1
LLO 2.1 Simulate the stereolithography process using a virtual lab.	2	Simulation of Stereolithography process	2	CO2
LLO 3.1 Describe the various steps involved in 3D scanning. LLO 3.2 Use 3D scanner to generate 3D model.	3	Generation of 3D model using 3D scanning technology	2	CO3
LLO 4.1 Create a 3D model using CAD software. LLO 4.2 Save and export the 3D model in various data exchange formats.	4	*3D model creation and export using various data exchange formats	2	CO3
LLO 5.1 Use slicing software to set the bed and nozzle temperatures. LLO 5.2 Use slicing software to select printing speed, material, and layer height.	5	*Setting up the bed temperature, nozzle temperature, printing speed, material selection, layer height in slicing software	2	CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 6.1 Use slicing software to adjust infill density, pattern, and object orientation. LLO 6.2 Use slicing software to select support material, wall thickness, and convert .stl to .gcode.	6	Setting up infill density, infill pattern, orientation of object, support material, wall thickness and converting .stl file to .gcode file in slicing software	2	CO3
LLO 7.1 Demonstrate the use of 3D printer to print a model with given infill density.	7	*3D printing at given infill density	2	CO4 CO5
LLO 8.1 Use appropriate tools to remove support material. LLO 8.2 Use appropriate tools to enhance surface texture, and improve accuracy of a printed model.	8	*Support material removal, surface texture enhancement, and accuracy improvement of printed model	2	CO5
LLO 9.1 Demonstrate the use of a 3D printer to print details of functional objects. LLO 9.2 Use appropriate tools to remove support material, enhance surface texture, and improve accuracy of printed objects.	9	*Printing and assembling multiple parts to create a functional object	2	CO3 CO4 CO5
LLO 10.1 Identify the common 3D printing defects. LLO 10.2 Resolve the issue that is causing defects in printing.	10	Troubleshooting common 3D printing issues such as layer shifting, warping, stringing, and under-extrusion.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Special Note : This list of suggestive microprojects are optional, as there is no SLA component and faculties may encourage students to perform any one of them.
- Design a joint mechanism for a robotic arm that allows for rotational or pivotal movement using CAD software, ensuring accurate dimensions for smooth movement, and print them using a 3D printer.
- Design a nut and bolt using CAD software, ensuring precise dimensions for a proper fit, and print the design using a 3D printer.
- Design a motor mount to securely hold a motor in place on a robot chassis using CAD software, ensuring accurate dimensions and print them using a 3D printer.
- Design a set of interlocking gears using CAD software, ensuring accurate dimensions for smooth movement, and print them using a 3D printer.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	3D Printer: Build volume- 250 x 250 x 250 mm, Layer resolution- 0.08-0.2 mm, Dimensional tolerance- ± 0.1mm, Print speed- 40-120 mm/sec, Extruder temperature- 280° C, Bed temperature- 100° C, Nozzle size- 0.4 mm, Power requirements- 230V, 50Hz, Supported file formats- .gcode.	1,7,10
2	High End Computers: Processor- i5 or above, RAM- 16 GB, SSD- 256 GB, Graphics Card- 4 GB.	2,3,4,5,6,9
3	3D Scanner: Handheld 3D scanner, Accuracy up to 0.1 mm, Resolution up to 0.2 mm, Scan speed up to 30fps, Texture scan, Real-time on-screen 3D model projection and processing, Along with Processing Software.	3
4	Parametric computer aided design software: like AutoDesk Inventor, FreeCAD, SolidWorks, AutoDesk Fusion 360, Creo, TinkerCAD etc.	3,4
5	Slicing software: like UltiMaker Cura, Simplify3D, Chitubox, PursaSlicer, Slic3r etc.	5,6,9
6	3D Printing material: Filament diameter- 1.75mm, Materials: ABS/PLA/Flexible/PETG etc.	7,10
7	Post-processing tools: Tool handle, Deburring blades, Electronic digital caliper, Cleaning needles, Art knife set, Long nose pliers, Flush cutters, Wire brush, Nozzle cleaning kit, Tube cutter, Print removal spatula, Needle file, Cutting mat, Glue stick, Wire stripper etc.	8,10

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Basics of 3D Printing	CO1	6	2	4	6	12
2	II	Additive Manufacturing Techniques	CO2	10	4	4	8	16
3	III	Model Preparation and Data Transfer	CO3	10	4	4	8	16
4	IV	Materials used for 3D Printing	CO4	6	2	4	6	12
5	V	Post-processing Techniques in 3D Printing	CO5	8	4	4	6	14
Grand Total				**40**	**16**	**20**	**34**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests of 30 marks and average of two-unit test marks will be consider for out of 30 marks.
- For formative assessment of laboratory learning 25 marks. Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks.
- End semester summative assessment of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	1	2	-	2	1	2			
CO2	2	2	3	-	2	1	3			
CO3	2	2	3	3	-	2	3			
CO4	3	2	3	-	3	2	3			
CO5	3	2	3	3	2	2	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Lan Gibson, David W. Rosen and Brent Stucker,	Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing	Springer Nature,2015, ISBN: 978-1493921126
2	Andreas Gebhardt	Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing	Hanser Publications, 2012, ISBN: 978-3446425521
3	Chee Kai Chua and Kah Fai Leong	3D Printing and Rapid Prototyping- Principles and Applications	World Scientific, 2019, ISBN: 978-0000987570
4	Sabrie Soloman	3D Printing and Design	Khanna Book Publishing, 2020, ISBN: 978-9386173768
5	Liza Wallach Kloski, Nick Kloski	Getting Started with 3D Printing: A Hands-on Guide to the Hardware, Software, and Services Behind the New Manufacturing Revolution	Make Community LLC, 2016, ISBN: 978-1680450200

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://onlinecourses.nptel.ac.in/noc21_me115/preview	Fundamentals of Additive Manufacturing Technologies (SWAYAM - NPTEL)

3D PRINTING **Course Code : 315351**

Sr.No	Link / Portal	Description
2	https://3dp-dei.vlabs.ac.in/Introduction.html	3D Printing Virtual Simulation Lab (Vlabs)
3	https://www.autodesk.com/solutions/3d-printing	3D Printing Process
4	https://ultimaker.com/software/ultimaker-cura/	Slicing Software - Cura
5	https://www.autodesk.com/education/edu-software/overview	3D modelling software - Autodesk Fusion 360
6	https://www.freecad.org/	3D modelling software - FreeCAD
7	https://www.simplify3d.com/resources/materials-guide/properties-table/	Filament Properties Table
8	https://support.3dverkstan.se/article/23-a-visual-ultimaker-troubleshooting-guide	Visual Ultimaker Troubleshooting Guide

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

INDUSTRIAL PROCESS CONTROL **Course Code : 315352**

Programme Name/s : **Automation and Robotics**
Programme Code : **AO**
Semester : **Fifth**
Course Title : **INDUSTRIAL PROCESS CONTROL**
Course Code : **315352**

I. RATIONALE

In the industrial environment, it is expected that an Automation and Robotics diploma graduate handles various industrial processes and control systems such as Distributed Control System (DCS), where parameters involved are required to be transmitted for efficient functioning of process operations. Also, selection of proper control schemes like feedback, feed forward and cascade for various unit operations such as heat exchanger, boiler etc. is important. Implementing proper safety methods is also essential in industrial processes. This course equips Automation and Robotics diploma graduates with the skills needed to handle process control systems effectively, enhancing their ability to work in process industries.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help students to attain the following industry / employer expected outcome through various teaching learning experiences -
"Maintain Industrial Process Control Systems."

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Describe the operation of a given process control system.
- CO2 - Apply the suitable process control action to the given unit operation.
- CO3 - Use appropriate safety method in process automation industries.
- CO4 - Describe the operation of a typical Distributed Control System.
- CO5 - Select the relevant Distributed Control System for a given application.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315352	INDUSTRIAL PROCESS CONTROL	IPC	DSE	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 10 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe with sketch the given type of process control. TLO 1.2 Describe feedback control loop with example. TLO 1.3 Differentiate between the electronic and pneumatic transmission system. TLO 1.4 Draw the Piping & Instrument Drawing symbol for the given process instrument.	**Unit - I Process Control Systems** 1.1 Process Control: Principle, block diagram of process control system, identification of elements, examples 1.2 Feedback control, feed forward control, cascade control - schematic diagram, concept and examples 1.3 Industrial signal transmission standards - Pneumatic and electronic transmission system: standard signal 1.4 Piping & Instrument Drawing symbols : ISA 5.1 symbols for basic field instruments in process loop	Lecture using Chalk-Board Presentations Video Demonstrations
2	TLO 2.1 Define unit operation and its types. TLO 2.2 Explain the working of the given heat exchanger process. TLO 2.3 Explain the working of the boiler process. TLO 2.4 Apply relevant control strategy to the given unit operation process.	**Unit - II Unit Operations in Process Industries** 2.1 Unit Operations: Definition and types 2.2 Heat exchanger process- Principle, operation, types of Heat exchanger- Shell and tube, Plate type 2.3 Boiler process - Principle, operation, safety interlocks 2.4 Application of feedback, feedforward and cascade control action to heat exchanger and boiler	Lecture using Chalk-Board Presentations Video Demonstrations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Select the appropriate material for the given hazardous location. TLO 3.2 Select appropriate protection method for the given application with justification. TLO 3.3 Identify the enclosures for the given hazardous location with justification. TLO 3.4 Explain the significance of SIS and SIL.	**Unit - III Safety in Process Automation Industries** 3.1 Hazardous area: Classification according to the materials as per NEC and IEC 3.2 Protection methods - Explosion proof, intrinsic safety using zener barrier, oil immersion and purging 3.3 Enclosures: IP classification, NEMA types 3.4 Safety Instrumented System (SIS) and Safety Integrity Levels (SIL) - Concept, Layer of Protection Analysis (LOPA)	Lecture using Chalk-Board Presentations Video Demonstrations
4	TLO 4.1 Explain the evolution of the DCS system. TLO 4.2 Explain with sketches the hierarchical control in automation. TLO 4.3 Describe the basic building block of a given DCS system. TLO 4.4 Describe the use of given I/P and O/P module. TLO 4.5 Explain with sketches the working of a given DCS module.	**Unit - IV Basics of Distributed Control System** 4.1 Evolution of DCS system -Hierarchical control in automation, Comparison of control system such as PLC , DCS and Hybrid controls 4.2 Basic building block of DCS System: Architecture and its operation, Architecture Redundancy 4.3 DCS Module : Input and output module: Local and remote I/O modules, controller module, power supply module	Lecture using Chalk-Board Presentations Video Demonstrations
5	TLO 5.1 Describe the function of a given DCS workstation. TLO 5.2 Describe the features of a given DCS . TLO 5.3 List the steps to carry out a typical maintenance procedure for DCS. TLO 5.4 Describe Functional block diagram with example	**Unit - V DCS Workstations** 5.1 Types of DCS workstations and their functions: Engineering workstation, Operator workstation, Diskless workstation, Historian workstation, Applications workstation, Portable workstation 5.2 DCS brands: Delta V, Simatic PCS 7- architecture and features 5.3 Typical DCS testing and troubleshooting procedure 5.4 Basics of Function block diagram (FBD) Programming : Introduction, Function blocks for standard logical functions, timer, counter, comparison blocks, FBD examples for simple application	Lecture using Chalk-Board Presentations Video Demonstrations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Demonstrate the use of process control loop. LLO 1.2 Identify the primary elements of a process control loop.	1	*Identification of different elements of a given process control loop	2	CO1
LLO 2.1 Interpret standard P&ID symbols and notation for representing equipment, piping, and instrumentation in a boiler process. LLO 2.2 Identify key control elements and safety devices in the P&ID diagram.	2	P&ID diagram for a given boiler process	2	CO1

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 3.1 Interpret standard P&ID symbols and notation for representing equipment, piping, and instrumentation in a Heat exchanger process. LLO 3.2 Identify key control elements and safety devices in the P&ID diagram.	3	P&ID diagram for a given Heat exchanger process	2	CO1
LLO 4.1 Use a feedback control loop to regulate any process. LLO 4.2 Troubleshoot common issues within a feedback control loop.	4	*Implementation of feedback control in any process using set up or simulator	2	CO2
LLO 5.1 Use cascade control loop to regulate any process. LLO 5.2 Troubleshoot common issues within a cascade control loop.	5	*Implementation of cascade control in any process using set up or simulator	2	CO2
LLO 6.1 Identify the types of different Hazardous areas.	6	*Identification of different types of Hazardous areas according to sample materials available in laboratory	2	CO3
LLO 7.1 Identify steps in hardware and software configuration of a DCS. LLO 7.2 Prepare detailed wiring diagrams for the installation of DCS.	7	*Preparation of configuration for DCS available in laboratory	2	CO4
LLO 8.1 Interface various I/O devices (sensors, actuators, etc.) with the appropriate I/O modules, of a given DCS. LLO 8.2 Verify the functionality of I/O interfaces in DCS.	8	Verification of functionality for the given I/O devices with relevant I/O module for the given DCS	2	CO4
LLO 9.1 Use HMI software to design a simple screen.	9	Preparation of HMI screen for any given simple application using appropriate software	2	CO5
LLO 10.1 Implement the use of FBD programming software for a simple application.	10	*Develop a simple FBD program for any given application.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Evaluate of Safety Instrumented Systems (SIS) and Safety Integrity Levels (SIL) Using LOPA.
- Describe and compare various safety interlocks used in boiler systems, their functions, and their impact on overall safety.
- Compare Pneumatic and Electronic Signal Transmission Systems.
- Determine the number of I/O s from given P&ID diagram.

Micro project

- Develop a process control loop for any industrial process parameter.
- Use feedback control loop for temperature control in furnace using paper sheet in the classroom.
- Prepare a chart on functional safety for the suggested industry.

- Develop Process & Instrument Drawing for industrial furnace process using paper sheet.
- Develop Process & Instrument Drawing for industrial distillation column process using paper sheet.
- Develop simple DCS program on given application

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Process control loop trainer setup for feedback, trainer setup for feedforward and trainer setup for cascade control system	1,4,5
2	Open source FBD programming software.	10
3	Boiler model or simulator	2,4
4	Heat exchanger model or simulator	3,4
5	Sample material such as - Cotton ,Oil, Kerosene, Asbestos Dust, Coal Dust etc.	6
6	Standard DCS system of reputed brand (such as Delta V, SIMATIC. PCS7) with analog and digital module, power supply module, communication module, controller module along with compatible software	7,8
7	HMI Panel with appropriate software.	9

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Process Control Systems	CO1	6	2	4	4	10
2	II	Unit Operations in Process Industries	CO2	10	4	6	8	18
3	III	Safety in Process Automation Industries	CO3	8	2	4	8	14
4	IV	Basics of Distributed Control System	CO4	8	4	6	4	14
5	V	DCS Workstations	CO5	8	2	4	8	14
Grand Total				**40**	**14**	**24**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests are of 30 marks and average of two unit test marks will be consider for out of 30 marks. For formative assessment of laboratory learning 25 marks. Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment is of 70 marks. End semester summative assessment is of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	1	1	1	1	1			
CO2	3	2	2	2	1	2	2			
CO3	3	1	1	1	1	1	2			
CO4	3	1	-	3	1	2	2			
CO5	3	2	2	3	1	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Johnson, C.D.	Process Control Instrumentation Technology	Prentice Hall of India, NewDelhi, 2017, ISBN: 978-0131194571
2	Smith, D.J. & Simpson, K.G.L.	Functional Safety: A Straightforward Guide to IEC61508 and Related Standards	Butterworth-Heinemann Publications. ISBN: 978-0750652704
3	Singh, S.K.	Industrial Instrumentation and Control	McGraw Hill Publications, New Delhi, 2016 , ISBN: 978-0070678200
4	Liptak, Bela G.	Instrumentation Engineers Handbook for Process Control	Chilton Book Company, New York, 2016, ISBN: 978-0801982422
5	Andrew, W.G. & Williams, H.B.	Applied Instrumentation in Process Industries	Gulf Publication Company, 2013, ISBN: 978-0872013827
6	Liptak, Bela G. & Eren, Halit	Instrument Engineer Handbook, Volume 3	CRC Press, 2016, ISBN: 978-1439863435
7	Mehta, B.R & Reddy, Jaganmohan Y.	Industrial Process Automation System: Design and Implementation	Butterworth Heinemann, 2014, ISBN: 978-0128010983
8	Bhatkar, Vijay P.	Distributed Computer Control System in Industrial Automation	Routledge,2017, ISBN: 978-1351454698
9	Moustafa Elshafei	Modern Distributed Control Systems: A Comprehensive Coverage of DCS Technologies and Standards	CreateSpace Independent Publishing Platform, 2016, ISBN: 978-1535103855

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description

INDUSTRIAL PROCESS CONTROL **Course Code : 315352**

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=lBARBZNLxQI	Fundamental components of Industrial Pneumatic Systems
2	https://en.wikipedia.org/wiki/Piping_and_instrumentation_diagram	Piping and Instruments (P&ID) Diagrams for various Equipments .
3	https://www.smartdraw.com/cad/piping-and-instrumentation-diagram-software.html	Free online software for creating P&ID
4	https://nptel.ac.in/courses/103105064	Course material on Process control and instrumentation
5	https://www.youtube.com/watch?v=jXRksET5vNo	Fundamentals of Distributed Control System
6	https://www.emerson.com/documents/automation/brochure-deltav-dcs-platform-deltav-en-7217850.pdf	Emerson Delta V DCS manual
7	https://ial-coep.vlabs.ac.in/List%20of%20experiments.html	Virtual Lab for Distributed Control System
8	https://www.youtube.com/watch?v=r8Bpc5MXqKI	FBD Tutorial video
9	https://www.codesys.com/download.html	Link to download free FBD software

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students