Maharashtra State Board Of Technical Education, Mumbai

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

Programme Name : Diploma In Mechatronics

Programme Code : MK | **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 Practical				Based on Self Learning		Total Marks
						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	EMERGING TRENDS IN MECHANICAL ENGINEERING	ETM	DSC	315363	-	3	-	-	-	3	1	1.5	30	70*#	100	40	-	-	-	-	-	-	100
2	INDUSTRIAL ROBOTICS	IRO	DSC	315364	-	5	-	4	-	9	3	3	30	70	100	40	25	10	25#	10	-	-	150
3	SEMINAR AND PROJECT INITIATION COURSE	SPI	AEC	315003	-	-	-	1	2	3	1	-	-	-	-	-	25	10	25@	10	25	10	75
4	RAPID PROTOTYPING SYSTEMS	RPS	DSC	315008	-	2	-	4	-	6	2	-	-	-	-	-	50	20	50#	20	-	-	100
5	MAINTENANCE OF INDUSTRIAL MECHATRONIC SYSTEMS	MIM	SEC	315009	-	1	-	2	-	3	1	-	-	-	-	-	50	20	25@	10	-	-	75
6	INTERNSHIP(12 WEEKS)	ITR	INP	315004	-	-	-	-	-	36 - 40	10	-	-	-	-	-	100	40	100#	40	-	-	200
Elective -I (Any - One)																								
7	MECHATRONICS SYSTEMS USING IOT	MIT	DSE	315365	-	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150
	PROCESS ENGINEERING	PEN	DSE	315366	-	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150
	PRODUCT DESIGN AND DEVELOPMENT	PDD	DSE	315367	-	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150
Total						**15**		**13**	**2**		**20**		**90**	**210**	**300**		**275**		**250**		**25**		**850**

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)

EMERGING TRENDS IN MECHANICAL ENGINEERING **Course Code : 315363**

Programme Name/s	**: Automobile Engineering./ Mechanical Engineering/ Mechatronics/ Production Engineering/**
Programme Code	**: AE/ ME/ MK/ PG**
Semester	**: Fifth**
Course Title	**: EMERGING TRENDS IN MECHANICAL ENGINEERING**
Course Code	**: 315363**

I. RATIONALE

As new technologies rapidly transform the manufacturing industry and related sectors, this course on Emerging Trends in Mechanical Engineering is designed to equip diploma pass outs with the latest knowledge essential for their professional growth. The course covers key areas such as green fuels, autonomous and sustainable maintenance practices, data analytics in manufacturing, and the integration of autonomous vehicles. It also explores the use of drones and autonomous technologies in agriculture. By focusing on these current trends, the course aims to enhance the skills of Mechanical, Automobile, Production, and Mechatronics diploma engineers, preparing them to excel in a rapidly evolving technological environment.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Adopt recent trends in mechanical engineering across various mechanical and allied industries.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Select appropriate green fuels for various applications for considering environmental sustainability.
- CO2 - Apply the principles of Autonomous and Sustainable maintenance practices in industry to improve equipment reliability and efficiency.
- CO3 - Identify the levels of autonomy in various mobility systems.
- CO4 - Use data analytics techniques to improve manufacturing processes and systems.
- CO5 - Utilize automated equipment and technologies for various agricultural applications.

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	
315363	EMERGING TRENDS IN MECHANICAL ENGINEERING	ETM	DSC	3	-	-	-	3	1	1.5	30	70*#	100	40	-	-	-	-	-	-	100

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

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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 concept of green fuels, including their benefits and advantages. TLO 1.2 Differentiate between the various classes of green fuels based on their sources and production methods. TLO 1.3 Describe different types of green fuels derived from plants.	**Unit - I Green Fuels** 1.1 Green Fuels: Introduction, Characteristics, Benefits and advantages. 1.2 Classes of Green Fuels: 1st Generation, 2nd Generation, 3rd Generation and 4th Generation Green Fuels 1.3 Types and Applications of Green Fuels: Biofuel, Hydrogen fuel, Synthetic fuel, Algae fuel, Bio diesel from plants, Applications of Green Fuels in Automobile, Power and Heat, Aerospace sectors.	Lecture Using Chalk-Board Presentations Video Demonstrations
2	TLO 2.1 Explain the concepts of data analytics, including its types and techniques. TLO 2.2 Describe the role of a data analyst in the manufacturing industry. TLO 2.3 Explain the characteristics of big data and its applications in manufacturing processes.	**Unit - II Recent trends in Manufacturing systems** 2.1 Big Data in Manufacturing: Introduction, Big Data Characteristics, Benefits 2.2 Data Analytics in manufacturing: Introduction, Steps in Data Analytics, Types of Data Analytics, Data Analytics techniques, Applications of Big Data analytics in Manufacturing – Preventive maintenance, Product Design, Production Management Automation, Customer Experience, Supply Chain Improvement, Benefits. 2.3 Data Analytics in Quality Control: Introduction, Applications, Benefits.	Lecture Using Chalk-Board Video Demonstrations Presentations
3	TLO 3.1 Explain the levels of autonomy in mobility systems. TLO 3.2 Describe the systems used in autonomous vehicles such as Advanced Driver Assistance Systems (ADAS) and Full Self-Driving (FSD) technologies. TLO 3.3 State the application of Autonomous Vehicles for given mobility system.	**Unit - III Autonomous Vehicles** 3.1 Autonomy in Mobility Systems (Autonomous Vehicle): Levels, Components, Benefits and Challenges. 3.2 Systems used in Autonomous Vehicles: Advanced Driver Assistance Systems (ADAS) and Full Self-Driving (FSD) 3.3 Applications of Autonomy in other Mobility Systems: Autonomous Trains, Autonomous Ships, Autonomous Aircrafts (Unmanned Aircraft Systems (UAS)	Lecture Using Chalk-Board Presentations Video Demonstrations
4	TLO 4.1 Describe the concept of Autonomous and Sustainable	**Unit - IV Recent Trends in Maintenance** 4.1 Autonomous Maintenance: Concept, Pillars of	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.
	Maintenance, including the pillars of Total Productive Maintenance (TPM). TLO 4.2 Explain the procedures of Autonomous and Sustainable Maintenance along with their benefits. TLO 4.3 Describe the role of data analytics in Predictive Maintenance. TLO 4.4 Explain the concept of Computerized Maintenance Management Systems (CMMS).	TPM, Implementation steps, benefits. 4.2 Sustainable Maintenance: Concept, Importance, Implementation steps, benefits. 4.3 Data Analytics in Predictive Maintenance: Introduction, concept of Computerized Maintenance Management System (CMMS).	Video Demonstrations Presentations
5	TLO 5.1 Explain the role of automation in agriculture field. TLO 5.2 Describe the benefits of automated farm equipment. TLO 5.3 Describe the features and advantages of autonomous tractors and their impact on enhancing agricultural practices. TLO 5.4 Describe the applications and advantages of using drones in agriculture sector. TLO 5.5 Explain significant features of government schemes supporting drone usage in agriculture field.	**Unit - V Recent Trends in Agriculture Engineering** 5.1 Automation in Agriculture: Introduction, Automated Farm Equipments - Agri-robots, Harvesting robots, Inspection and Monitoring Agriculture robots, Automatic Seeding and Planting Machine, AI Operated Irrigation Systems, Benefits 5.2 Autonomous Tractor: Self Driving Tractors, Features and Advantages 5.3 Agricultural Drones: Soil and Field Analysis, Crop Monitoring, Plantation, Crop Spraying, Advantages of Drones, Government Schemes for Drone Usage.	Lecture Using Chalk-Board Presentations Video Demonstrations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES : NOT APPLICABLE.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING) : NOT APPLICABLE

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Not Applicable	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	Green Fuels	CO1	5	2	4	4	10

EMERGING TRENDS IN MECHANICAL ENGINEERING **Course Code : 315363**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
2	II	Recent trends in Manufacturing systems	CO2	6	4	4	8	16
3	III	Autonomous Vehicles	CO3	6	4	4	6	14
4	IV	Recent Trends in Maintenance	CO4	6	2	4	8	14
5	V	Recent Trends in Agriculture Engineering	CO5	7	4	4	8	16
Grand Total				**30**	**16**	**20**	**34**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two Class test of 30 Marks and Average of two Class test

Summative Assessment (Assessment of Learning)

- Online MCQ based examination - 70 marks

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	-	-	-	2	-	3			
CO2	3	-	-	-	2	-	3			
CO3	3	-	-	-	2	-	3			
CO4	3	-	-	-	2	-	3			
CO5	3	-	-	-	3	-	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	Carlos Ricardo Soccol, Satinder Kaur Brar, Craig Faulds, Luiz Pereira Ramos	Green Fuels Technology: Biofuels (Green Energy and Technology)	Springer International Publishing AG; 1st ed. 2016 edition (19 August 2016); 01149344934, ISBN-13: 978-3319302034
2	Fumio Gotoh	Autonomous Maintenance in Seven Steps: Implementing	1st Edition, Productivity Press, ISBN-13: 978-0367199869

Sr.No	Author	Title	Publisher with ISBN Number
		TPM on the Shop Floor	
3	Samuel Theodore, Daniel Lucky	Autonomous Maintenance	Maintenance Pro, 2023, ISBN-13 ?:979-886417453
4	Matthias Hartwig	Self-driving cars	E-book, 2020, by BMW
5	George Dimitrakopoulos, Aggelos Tsakanikas, Elias Panagiotopoulos	Autonomous Vehicles Technologies, Regulations, and Societal Impacts	Elsevier,2021, ISBN-13: 978-0323901376
6	Yan Li, Hualiang Shi	Advanced Driver Assistance Systems and Autonomous Vehicles	Springer, Singapore,2022, ISBN-13: 978-9811950520
7	P Suresh, T. Poongodi, B Balamurugan, Meenakshi Sharma	Big Data Analytics in Smart Manufacturing: Principles and Practices	December 14, 2022 by Chapman & Hall, ISBN-13: 978-1032065519
8	Rania I.M. AlmoselhyRania I.M. Almoselhy, Ravindran Chandran, Abisha Juliet Mary S J	Current Trends in Agriculture & Allied Sciences (Volume-1)	S. P. Publishing, Bhubaneshwar, Odisa,2023, ISBN-13: 978-9359061382
9	Dr. Suman Lata, Mamta J. Patange, Dr. Anand K. Gore, Suchibrata Chamuah and Dr. Chandana Behera	Recent Trends in Agriculture (Volume-5)	Integrated Publications, New Delhi,2023, ISBN-13: 978-9395118644

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.engieimpact.com/insights/green-fuels	Green Fuels
2	https://www.youtube.com/watch?v=T_S7Q3Uede4	Green Fuels
3	https://www.researchgate.net/publication/359732622_Green_fuels_concepts_benefits_and_studies_in_Nigeria/link/624c10bec7ab230e99cef13a/download?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uIn19	Green Fuels
4	https://nitsri.ac.in/Department/Chemical%20Engineering/BRTL12.pdf	Green Fuels
5	https://www.youtube.com/watch?v=4-R5Sh-xSiI&t=5s	Autonomous Maintenance (Total Productive Maintenance Series TPM)
6	https://www.youtube.com/watch?v=ZJ6tr1kkRDg	Sustainability in Manufacturing
7	https://www.youtube.com/watch?v=HgF7E5q9sU4&t=1s	An introduction to autonomous vehicles
8	https://www.youtube.com/watch?v=gEy91PGGLR0	Autonomous car / self-driving car
9	https://www.youtube.com/watch?v=ACxTcsxSYvE	Data Analytics in Manufacturing
10	https://www.youtube.com/watch?v=31W0EzcfE74	Big data analytics for manufacturing
11	https://www.youtube.com/watch?v=P2YPG8PO9JU	Agricultural Wonder Drone
12	https://www.youtube.com/watch?v=8-uPCmHX3U0	Agricultural Drones
13	https://www.youtube.com/watch?v=JeU_EYFH1Jk	Artificial intelligence comes to farming in India
14	https://www.youtube.com/watch?v=tSdIgGin_rk	Fully autonomous tractor

EMERGING TRENDS IN MECHANICAL ENGINEERING **Course Code : 315363**

Sr.No	Link / Portal	Description
15	https://www.skillindiadigital.gov.in/courses/detail/32d86c56-efc6-4c33-9c65-17901e296f8e	Kisan Drone Operator
16	https://www.youtube.com/watch?v=q7tFDw5SAAU	Farming with robots
17	https://www.youtube.com/watch?v=_Dmb1GN52no	Spraying robots

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 ROBOTICS **Course Code : 315364**

Programme Name/s : **Mechatronics**
Programme Code : **MK**
Semester : **Fifth**
Course Title : **INDUSTRIAL ROBOTICS**
Course Code : **315364**

I. RATIONALE

Industrial robots are widely used in many industrial applications, to make industries more competitive and efficient. The most obvious impact of industrial robots is that they eliminate many dull, dirty, dear, difficult and dangerous tasks. The use of robot helpful in hazardous and challenging environments. The purpose of industrial robotics course is to provide skilled workforce to the industry.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Operate industrial robot for the given industrial applications.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Select robot for given application.
- CO2 - Select end effectors, actuators and sensors for given robotic applications.
- CO3 - Apply robot vision system for given application.
- CO4 - Develop robot program for given applications.
- CO5 - Indentify future technologies to integrate with industrial 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	
315364	INDUSTRIAL ROBOTICS	IRO	DSC	5	-	4	-	9	3	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 :

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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 fundamental terminology in robotics. TLO 1.2 Select robot configuration for the given application. TLO 1.3 Explain basic elements of robotic system. TLO 1.4 Select robot specification for the given application. TLO 1.5 Choose robot motions for the given application. TLO 1.6 Simulate different joints used in robotic systems.	**Unit - I Components of Robotics System** 1.1 Fundamentals of robotics: Introduction, definition, need, brief history, laws of robot. 1.2 Robot configurations: Polar (Spherical), Cylindrical, Cartesian coordinate, Jointed arm (Articuted), SCARA (Selective Compliance Assembly Robot Arm). 1.3 Elements of robot system (Robot Anatomy): Base, Manipulator arm, End Effectors, Sensors and transducers, Actuators and Drives, Control systems. 1.4 Robot specification: Degree of Freedom, Work envelope, Load carrying capacity, Speed of movement, Accuracy, Repeatability, Control Resolution, Spatial resolution. 1.5 Robot motions: Vertical motions, Radial motions, Rotational motions, Pitch motions, Roll motions, Yaw motions. 1.6 Types mechanical joints used in robotics system: Linear Joint, Orthogonal joint, Rotational Joint, Twisting Joint, Revolving Joint (Symbols, Notations).	Lecture Using Chalk-Board PPT Demonstrations Video Flipped Classroom
2	TLO 2.1 Select end effector for the given application. TLO 2.2 Compare different actuators for robotic system. TLO 2.3 Select robot sensor for the given application.	**Unit - II Robot - Gripper, Actuators and Sensors** 2.1 Robots End Effectors: Types of End Effectors - Gripper and Tools, Grippers- Mechanical, Pneumatic, Magnetic, Vacuum, adhesive, Considerations in gripper selection. 2.2 Actuators and drives: Pneumatic, Hydraulic, Electric. 2.3 Robotic Sensors: Introduction to Sensors in robotics, classification of Sensors – Tactile Sensors, Touch sensors, Force sensors, Force sensing wrist, Joint sensing, Tactile array sensors, Proximity and Range Sensors, Miscellaneous Sensors and Sensor based Systems, Uses of Sensors in Robotics. 2.4 Desirable features of sensors in Robotics.	Lecture Using Chalk-Board PPT Video Case study
3	TLO 3.1 Construct flowchart of robot vision system. TLO 3.2 Describe role of image processing in robot vision system. TLO 3.3 Use of robot vision system for the given application.	**Unit - III Robot Vision System** 3.1 Robot Vision: Introduction, The Sensing and Digitizing Function - Imaging devices, Lighting techniques, Analog to Digital signal conversions (Sampling, Encoding, Image storage). 3.2 Image Processing and Analysis: Image Data reduction, Segmentation, Thresholding, Region growing, Edge detection, Feature extraction, Object Recognition. 3.3 Industrial application of vision controlled Robotic system.	Lecture Using Chalk-Board PPT Video
4	TLO 4.1 Use of different robotic commands for	**Unit - IV Introduction to Robot Languages & Programming** 4.1 Introduction to Robot Languages: The Textual Robot	Lecture Using Chalk-Board PPT

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.
	programming robot. TLO 4.2 Describe Robot language structure. TLO 4.3 Select robot programming method for the given application. TLO 4.4 Develop Robot programs for the given industrial application.	Languages, Generations of Robot Programming Languages, Robot Language Structure, Constant, Variables and other Data Objects, Motion Commands, End Effecter and Sensor Commands, Computations and Operations, Program Control and Sub-routines, Communications and Data Processing, Monitor Mode Commands. 4.2 Introduction to Robot Programming: Methods of Programming a Robot, Lead through Programming Methods, Robot Programme as a Path in Space, Motion Interpolation, WAIT, SIGNAL and DELAY Commands, Branching, Capabilities and Limitations of Lead through Methods. 4.3 Introduction to Teach Pendant. 4.4 Simple Program for Pick and place activity. 4.5 Simple Program to Palletize the object. 4.6 Simple Program for Inspection (Bolt, PCB, Bearing etc.).	Video Demonstration
5	TLO 5.1 Indentify type of robot used for the given industrial applications. TLO 5.2 Identify future technology in robotics for the given industrial applications. TLO 5.3 Explain future use of robots in various application.	**Unit - V Robot Applications & Future Technology** 5.1 Robots in material handling. 5.2 Robots in processing operations - Spot welding, Continuous arc welding, Plastic spray coating, Die-casting, molding, Forging operation. 5.3 Robots in automated assemblies & inspections. 5.4 Future technology in robotics: Introduction, Robot intelligence, Advanced sensor capabilities (3D Vision), Telepresence and related technologies, Mechanical design features (Direct Drive robot, Multiple arm coordinate robot), Mobility, locomotion and navigation, Universal hand, System integration and network. 5.5 Future applications of Robots: Military operations, Fire-fighting operations, under sea operations, Space operations, Industry 4.0, AI in industrial robotics.	Lecture Using Chalk-Board PPT Video Case study Field Visit

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 different robotic components and its working for the given system.	1	*Robotic components and its working.	2	CO1
LLO 2.1 Simulate the robot configuration with 3 DoF for planer robot.	2	*Robot motion simulation of Cartesian Robot using software.	2	CO1
LLO 3.1 Simulate the robot configuration with 4 DoF for spatial robot.	3	Robot motion simulation of SCARA Robot using software.	2	CO1
LLO 4.1 Simulate the robot configuration with 6 DoF for spatial robot.	4	Robot motion simulation of Articulated Robot (6 DoF) using software.	2	CO1

INDUSTRIAL ROBOTICS **Course Code : 315364**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 5.1 Use end effector for the given application.	5	*End effector interfacing with robotic system.	2	CO2
LLO 6.1 Use sensors for the given robotic system.	6	Sensor interfacing with robotic system.	2	CO2
LLO 7.1 Operate robot with different motion commands for the given situation.	7	*Robot simulation by using motion commands.	2	CO4
LLO 8.1 Operate robot with different end effector commands for the given application.	8	Robot simulation by using end effector commands.	2	CO4
LLO 9.1 Develop program for path movement. LLO 9.2 Operate robot for the given path movement.	9	Program for specific path movement of robot.	2	CO4
LLO 10.1 Develop program for pick and place activity. LLO 10.2 Operate robot for pick and place activity.	10	Program for pick and place activity.	2	CO4
LLO 11.1 Develop program for palletizing the object. LLO 11.2 Operate robot for palletizing the object.	11	*Program for palletizing the object.	2	CO4
LLO 12.1 Calibrate the vision system with robot coordinate system.	12	Calibration of robot vision system	2	CO3
LLO 13.1 Develop program for inspection of the object. LLO 13.2 Use robot vision system for inspection.	13	*Program for inspection. (Bolt, PCB, Bearing etc.)	2	CO3 CO4
LLO 14.1 Interface PLC with robotic system for the given application.	14	*PLC interfacing with robotic system as per standard procedure.	2	CO4
LLO 15.1 Use robot vision system for sorting the given objects on shape basis.	15	Program for sorting objects as per shape (square, cicle etc).	2	CO3 CO4 CO5
LLO 16.1 Develop program for spot/ arc welding operation. LLO 16.2 Operate robot for welding application.	16	*Program for spot/ arc welding operation.	2	CO4 CO5
LLO 17.1 Develop program for spot painting operation. LLO 17.2 Operate robot for painting application.	17	Program for painting operation.	2	CO4 CO5
LLO 18.1 Develop program for tightening and loosing the fasteners with torque gun. LLO 18.2 Operate robot for assembly work with torque gun.	18	*Program for tightening and loosing the fasteners with torque gun.	2	CO4 CO5
LLO 19.1 Operate robot to write the given word.	19	*Program robot for writing name of your institute.	2	CO4 CO5
LLO 20.1 Interface conveyer with robotic system. LLO 20.2 Operate conveyer with robotic	20	Program for interfacing of conveyer.	2	CO4 CO5

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
system.				

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) : NOT APPLICABLE

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	PLC (Min 8 input/output)	1,16
2	Programmable Robot Trainer Kit with standalone servo controller as well as compatible PLC interface with following features: 1) Minimum 3 linkages 2) Minimum 4 degree of freedom (4DoF) 3) Various sensors 4) Compatible Robot vision system for inspection.	1,4,5,6,7,8,9,10,11,12,13,14,16
3	End effector - Grippers – Minimum two (Mechanical, Pneumatic, Vacuum, Magnetic etc.)	1,5,8,10,11,12
4	End effector - Tools – Weld gun, spray gun, torque gun, Pen Holder etc.	1,5,8,10,11,16,17,18,14,15,19
5	Robot offline simulation software	2,3
6	Computers with internet connectivity (Minimum Core i5 Processor, 8GB RAM, 500GB HDD)	2,3,9,10,11,12,13,14

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	Components of Robotics System	CO1	11	4	4	6	14
2	II	Robot - Gripper, Actuators and Sensors	CO2	12	2	6	8	16
3	III	Robot Vision System	CO3	8	2	4	6	12
4	IV	Introduction to Robot Languages & Programming	CO4	12	2	4	12	18
5	V	Robot Applications & Future Technology	CO5	7	2	4	4	10
Grand Total				**50**	**12**	**22**	**36**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- For laboratory learning Maximum 25 Marks and Minimum 10 Marks.
- Two-Class Tests of 30 marks and average of Two-Class Tests out of 30.

Summative Assessment (Assessment of Learning)

- • End Semester External Assessment of Maximum 25 Marks and Minimum 10 Marks for laboratory learning.
- • End Semester Assessment of 70 marks for theory 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	3	3	2	-	1	1			
CO2	3	3	3	2	-	1	1			
CO3	3	3	3	3	-	1	1			
CO4	3	3	3	3	-	1	1			
CO5	3	1	1	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	Mikell P. Groover, Michell Weiss, Roger N. Nagel, Nicholas G. Odrey & Ashish Dutta	Industrial Robotics	McGraw Hill Education (India) Pvt. Ltd., Chennai, 2012, ISBN: 9781259006210
2	Ramchandran Nagarajan	Introduction to Industrial Robotics	Pearson Education India, New Delhi, 2016, ISBN: 9789332544802
3	R. K. Rajput	Robotics and Industrial Automation	S. Chand limited, 2014, ISBN: 9788121929974
4	R. K. Mittal & I. J. Nagrath	Robotics and Control	McGraw Hill education India Pvt. Ltd. New Delhi, 2010, ISBN: 9780070482937
5	Ganesh S. Hegde	A Textbook on Industrial Robotics	University Science Press, New Delhi, 2015, ISBN: 9788131805183
6	D. J. Todd	Fundamentals of Robot Technology	British library Cataloguing in Publication Data, 2012, ISBN: 9789401167703
7	Ghosal, Ashitava	Robotics – Fundamental Concepts and Analysis	Oxford University Press, 2006, ISBN: 978019567391

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://nptel.ac.in/courses/112105319	NPTEL Course - Industrial Robotics: Theories for Implementation

INDUSTRIAL ROBOTICS **Course Code : 315364**

Sr.No	Link / Portal	Description
2	https://nptel.ac.in/courses/112105249	NPTEL Course - Robotics
3	http://www.mechanalyzer.com/downloads-roboanalyzer.html	Simulation Software- Robo analyzer (Download)
4	http://www.roboanalyzer.com/tutorials.html	Simulation Software - tutorials
5	https://www.youtube.com/watch?v=l1gRr_NI4BU	Introduction to Industrial Robot
6	https://www.youtube.com/watch?v=X7iBT5l599c	Industrial Robot Manipulator
7	https://www.youtube.com/watch?v=_canCYWZPsc&t=227s	Animation of Work Envelope
8	http://vlabs.iitkgp.ernet.in/mr/exp0/index.html#	Virtual Lab – 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

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/ Resources 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)

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INDEX

Sr. No.	Chapter	Page No.
1.	Chapter–1 Introduction (background of the seminar)	**1**
2.	Chapter–2 Literature review for the seminar topic/theme	**5**
3.	Chapter–3 -	
-	-	
-	Seminar Report	
-	**Bibliography**	
-	**Referances**	

***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)	Scaled 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)**

RAPID PROTOTYPING SYSTEMS **Course Code : 315008**

Programme Name/s : Mechatronics
Programme Code : MK
Semester : Fifth
Course Title : RAPID PROTOTYPING SYSTEMS
Course Code : 315008

I. RATIONALE

Rapid prototyping methods are vital in modern engineering, manufacturing, and design because they allow ideas to be quickly transformed into functioning prototypes. This topic teaches diploma students skills such as solid modeling and 3D printing of cost-effective components. It prepares students to flourish in industrial situations by encouraging creativity, efficiency and practical problem-solving skills.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Apply Rapid Prototyping systems to produce cost-effective 3D printed components.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Develop a 3D solid model for a given drawing.
- CO2 - Select a relevant rapid prototyping process.
- CO3 - Select relevant material for manufacturing of prototype.
- CO4 - Develop the given prototype by using the FDM 3D printing process.

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	
315008	RAPID PROTOTYPING SYSTEMS	RPS	DSC	2	-	4	-	6	2	-	-	-	-	-	50	20	50#	20	-	-	100

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 Select relevant parametric solid modeling software with justification. TLO 1.2 Choose sketcher tools for 2D Drawing. TLO 1.3 Use different modeling tools for 3D Drawing. TLO 1.4 Identify different steps of 3D models for the parts of the given assembly with minimum tree.	**Unit - I Solid Modeling for Rapid Prototyping** 1.1 Overview of parametric solid modeling software 1.2 Drawing/Sketcher, Editing, modify tools: Line, Rectangle, Circle, Trim, Spline, Mirror, etc. 1.3 Dimensioning constraint and Geometrical constraint. 1.4 Part tool: Extrude, Hole, Revolve, Rib, Sweep, swept blend, Pattern, etc. 1.5 Part Editing tool: Trim, Extend, Erase, Mirror etc. 1.6 Part Modify tool: Chamfer, Round, Copy, Move, Draft, etc.	Chalk-Board Presentations Video
2	TLO 2.1 Explain the concept of Rapid Prototyping. TLO 2.2 Select relevant rapid prototyping process with justification.	**Unit - II Introduction to Rapid Prototyping** 2.1 Definition and the concept of Rapid Prototyping (Additive Manufacturing) 2.2 Differences between AM and traditional manufacturing, advantages and limitations. 2.3 Types of Additive Manufacturing Technologies : Stereolithography (SLA), Selective Laser Sintering (SLS), Fused Deposition Modeling (FDM), Digital Light Processing (DLP) , Electron Beam Melting (EBM), Laminated Object Manufacturing (LOM) . Applications, advantages and limitations 2.4 Introduction to 3D Scanner	Chalk-Board Video Presentations
3	TLO 3.1 Explain the FDM process cycle. TLO 3.2 Select relevant material in the FDM printing process. TLO 3.3 Explain working of the FDM 3D printer and its Parts.	**Unit - III FDM 3D Printing** 3.1 Introduction to the FDM Process 3.2 Generic FDM Process cycle 3.3 Materials for FDM Process PLA, PETG, Nylon, ABS etc. Applications, advantages and limitations 3.4 Working of FDM 3D printer and its Parts- Nozzle, Print Bed, Belts, Motors etc.	Chalk-Board Video Presentations
4	TLO 4.1 Select printing parameters for creating parts. TLO 4.2 Apply post processing operations on 3D printed parts.	**Unit - IV Software and Post processing** 4.1 Overview of Printing Software (Slicer) 4.2 Basic printing process parameters : Layer Height, Shell thickness, Infill Density, Infill Pattern etc 4.3 Post processing : Support removal and Surface Finishing, Painting etc.	Chalk-Board videos Presentations

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

RAPID PROTOTYPING SYSTEMS **Course Code : 315008**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Draw Circle, Rectangle, ellipse and simple 2D component using sketcher commands.	1	*Use the sketcher command to draw simple 2D components.	2	CO1
LLO 2.1 Draw Simple 2D components using Trim, Mirror, move, copy commands.	2	*Use the Modify command to draw simple 2D components.	2	CO1
LLO 3.1 Draw Universal coupling using 2D sketcher commands.	3	Use 2D sketcher commands to draw a given component.	2	CO1
LLO 4.1 Develop 3D model of Cylinder, cube, rectangular plate using 3D modeling commands.	4	*Draw component using 3D modeling commands.	2	CO1
LLO 5.1 Develop 3D model of tool post using 3D modeling commands.	5	*Draw 3D model of assembly-1 using basic commands.	2	CO1
LLO 6.1 Develop 3D model of Drill jig using 3D modeling commands.	6	Draw 3D model of assembly-2 using basic commands	2	CO1
LLO 7.1 Develop a 3D model of Oldham's coupling using 3D modeling commands.	7	Draw a 3D model of assembly-3 using basic commands.	2	CO1
LLO 8.1 Develop a 3D model of Universal coupling using 3D modeling commands.	8	*Draw 3D model of assembly-4 using basic commands.	2	CO1
LLO 9.1 Identify different Rapid prototyping processes to prepare prototype models and give justification.	9	Rapid prototyping process	2	CO2
LLO 10.1 Identify different filament materials for FDM 3D printing and give justification.	10	FDM 3D Printing filament	2	CO3
LLO 11.1 Tessellation of CAD file to STL file using printing parameters	11	*Convert the CAD model and configure print settings for optimal results.	2	CO4
LLO 12.1 Apply Print-Bed Calibration and load filament	12	*Print-bed calibration and loading of the filament.	2	CO4
LLO 13.1 Develop the 3D print model of the cube using PLA filament.	13	Print a 3D model of a Solid component	2	CO4
LLO 14.1 Develop a 3D model of any sliding pair of square blocks and square bars using PETG /ABS/Nylon filament.	14	*Print sliding pair using FDM 3D print model.	2	CO4
LLO 15.1 Develop a given Gear Pair 3D print model using different filaments. PETG /ABS/ Nylon filament	15	Print FDM 3D model of any Gear Pair.	2	CO4
LLO 16.1 Generate support for curved overhang model	16	Print curved overhang model using FDM 3D printer.	2	CO4
LLO 17.1 Generate support for the square overhang model	17	*Print Square Overhang model using FDM 3D printer	2	CO4
LLO 18.1 Apply Post process to the 3D printed object.	18	Post-process operations to the overhang prototype.	2	CO4
LLO 19.1 Develop ASTM D 638 Tensile Test specimen using PLA filament.	19	*Print the given ASTM D 638 3D print model.	2	CO4
LLO 20.1 Develop Knuckle Joint 3D print model using PLA filament.	20	Print Knuckle Joint 3D model.	2	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs

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) : NOT APPLICABLE

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Hardware: FDM 3D Printer	8,9,10,11,12,13,14,15,16,17,18
2	Software: 3D printing software (slicing software).	8,9,10,11,12,13,14,15,16,17,18
3	Filament PLA, PETG, Nylon, ABS	8,9,10,11,12,13,14,15,16,17,18
4	Hardware: Personal Computer, (i3/i5 or higher),RAM min.4GB.Display wide screen preferable	All
5	Operating system: Windows 7/ Windows 8/ Windows 10 or Higher.	All
6	Software: Any parametric solid modeling 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	Solid Modeling for Rapid Prototyping	CO1	5	0	0	0	0
2	II	Introduction to Rapid Prototyping	CO2	6	0	0	0	0
3	III	FDM 3D Printing	CO3	5	0	0	0	0
4	IV	Software and Post processing	CO4	4	0	0	0	0
Grand Total				**20**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Lab Wok , Viva

Summative Assessment (Assessment of Learning)

- Practical Exam

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	2	2	1	1	-	1			
CO2	3	2	2	-	1	-	1			
CO3	3	2	2	-	1	-	1			
CO4	3	2	2	-	1	-	1			

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	Prof. Sham Tickoo	CATIA V5-6R2023 for Designers	CADCIM Technologies, 21 st Edition 2024,ISBN:-978-1640572409.
2	Prof. Sham Tickoo	Solid Edge ST10 for Designers	BPB,15 th Edition, 2018, ISBN:-978-9387284104.
3	Prof. Sham Tickoo	SOLIDWORKS 2023 for Designers	CADCIM Technologies, USA, 21st edition, 2024, ISBN:-978-1-64057-172-3
4	Ian Gibson, David W. Rosen, Brent Stucker.	Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing	Springer, 2nd Edition, 2014, ISBN:-978-1493921133
5	Ben Redwood, Mr.Filemon Schoffer, Mr.Brian Garret.	The 3D Printing Handbook: Technologies, design and applications	3D Hubs, First Edition, 2017, ISBN:-978-9082748505
6	Sheku Kamara, Kathy S. Faggiani	Fundamentals of Additive Manufacturing for the Practitioner	Wiley, First addition 2021, ISBN:-978-1-119-75038-3
7	Tyler Kerr	3D Printing Introduction to Accessible, Affordable Desktop 3D Printing	Springer Cham, First addition 2022, ISBN978-3-031-19352-1
8	Gary C. Confalone, John Smits, Thomas Kinnare	3D Scanning for Advanced Manufacturing, Design, and Construction	Wiley, First addition,2023 ISBN: 978-1-119-75851-8

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=vjX4PDJcFOI	Solid Modeling
2	https://www.youtube.com/watch?v=t7yv4gSnNkE	Fundamentals of Additive Manufacturing Technologies
3	https://www.youtube.com/watch?v=9JTRqfNAqhM	Introduction to Additive Manufacturing
4	https://www.youtube.com/watch?v=htMr1oFE7Zg	CAD Models for Additive Manufacturing

Note :

RAPID PROTOTYPING SYSTEMS **Course Code : 315008**

Sr.No	Link / Portal	Description

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

MAINTENANCE OF INDUSTRIAL MECHATRONIC SYSTEMS **Course Code : 315009**

Programme Name/s : **Mechatronics**
Programme Code : **MK**
Semester : **Fifth**
Course Title : **MAINTENANCE OF INDUSTRIAL MECHATRONIC SYSTEMS**
Course Code : **315009**

I. RATIONALE

Maintenance of industrial mechatronics systems encompasses strategic requirements such as avoid accident and breakdown. Also minimizing downtime, enhancing reliability, ensuring safety and compliance, optimizing efficiency, supporting quality assurance, and smoothing workforce development. These aspects collectively contribute to sustained operational excellence, cost-effectiveness, and competitive advantage in industrial sectors depending on mechatronics technology.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Maintain different industrial mechatronics system.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Apply different industrial maintenance methods.
- CO2 - Troubleshoot electrical and electronic systems in industry.
- CO3 - Troubleshoot mechanical systems in industry.
- CO4 - Troubleshoot industrial robotics systems.

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	
315009	MAINTENANCE OF INDUSTRIAL MECHATRONIC SYSTEMS	MIM	SEC	1	-	2	-	3	1	-	-	-	-	-	50	20	25@	10	-	-	75

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 importance of industrial Maintenance. TLO 1.2 Describe the types of Maintenance. TLO 1.3 Prepare maintenance plan for mechatronics system. TLO 1.4 Discuss the role and responsibilities of a Mechatronics Maintenance Specialist and steps for troubleshoot.	**Unit - I Fundamental of Industrial Maintenance.** 1.1 Importance of industrial maintenance. 1.2 Types of maintenance: (a) Preventive maintenance (b) Corrective maintenance (c) Total productive maintenance (TPM). 1.3 Prepare Maintenance chart for mechatronics system, fault diagnosis, troubleshoot, repair.	Video Demonstrations Presentations Lecture Using Chalk-Board Hands-on
2	TLO 2.1 Explain importance of drive system and sensor. TLO 2.2 Identify various faults, causes and suggest remedy for failure in servo motor, stepper motor. TLO 2.3 Identify various faults, causes and suggest remedy for failure in sensor. TLO 2.4 Identify various faults causes and suggest remedy for failure in microcontrollers and PLC. TLO 2.5 Prepare maintenance chart for electrical and electronic system. TLO 2.6 Explain safety precaution.	**Unit - II Maintenance of Electrical and Electronic System.** 2.1 Discuss importance of drive system:(a) servo motor (b)stepper motor, and sensor: position sensors, velocity sensors, pressure and torque sensor. 2.2 Explain maintenance of drive system and sensor. 2.3 Explain maintenance of microcontrollers and PLC. 2.4 Explain safety precaution taken during electrical and electronic maintenance.	Video Demonstrations Presentations Lecture Using Chalk-Board Hands-on
3	TLO 3.1 Identify various faults, causes and suggest remedy for failure in industrial hydraulic pump. TLO 3.2 Identify various faults, causes and suggest remedy for failure in compressors. TLO 3.3 Identify various faults, causes and suggest remedy for failure in valve. TLO 3.4 Identify various faults, causes and suggest remedy for failure in actuator. TLO 3.5 Explain safety precaution.	**Unit - III Maintenance of mechanical system.** 3.1 Explain maintenance of hydraulic pump: Gear pump, Vane pump, lobe pump, axial piston pump. 3.2 Explain maintenance of compressor: vane and screw compressor. 3.3 Explain maintenance of industrial valve and actuator: pressure control valve, pressure relief valve, pressure reducing valve, sequence valve, and linear and rotary actuators. 3.4 Explain leakage finding in hydraulic and pneumatic system. 3.5 Explain safety precaution taken during industrial mechanical maintenance.	Video Demonstrations Presentations Lecture Using Chalk-Board Hands-on

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 need of industrial robot and CNC machine. TLO 4.2 Identify fault in industrial robot. TLO 4.3 Implement remedial action to remove minor fault in robot. TLO 4.4 Identify fault in CNC machine. TLO 4.5 Implement remedial action to remove minor fault in CNC machine. TLO 4.6 Describe the interlocking of robot. TLO 4.7 Explain safety precaution.	**Unit - IV Maintenance of industrial robot and CNC machine.** 4.1 Discuss common trouble and suggest remedy in robot operation and CNC machine. 4.2 Introduction on interlocking of robot. 4.3 Explain safety precaution taken during industrial robot and CNC machine maintenance.	Video Demonstrations Presentations Lecture Using Chalk-Board Hands-on

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 Troubleshoot servo motor, give their causes and suggest remedy. LLO 1.2 Troubleshoot stepper motor, give their causes and suggest remedy. LLO 1.3 Install and test of electrical drive system. LLO 1.4 Follow safety precautions.	1	* Troubleshoot electrical drive system.	2	CO1 CO2
LLO 2.1 Troubleshoot pressure sensor and velocity sensor, give their causes and suggest remedy. LLO 2.2 Troubleshoot position sensor and torque sensor, give their causes and suggest remedy. LLO 2.3 Install and test given sensor. LLO 2.4 Follow safety precautions.	2	Troubleshoot sensors.	2	CO1 CO2
LLO 3.1 Develop preventive maintenance chart for electrical system. LLO 3.2 Develop preventive maintenance chart for electronics system.	3	Prepare preventive maintenance chart, checklist for electrical/electronic system.	2	CO1 CO2
LLO 4.1 Troubleshoot Gear pump and Vane Pump, give their causes and suggest remedy. LLO 4.2 Troubleshoot lobe pump, axial piston pump, give their causes and suggest remedy. LLO 4.3 Install and test of given hydraulic pump. LLO 4.4 Follow safety precautions.	4	* Troubleshoot hydraulic pump.	2	CO1 CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 5.1 Troubleshoot Vane compressor, give their causes and suggest remedy. LLO 5.2 Troubleshoot Screw compressor, give their causes and suggest remedy. LLO 5.3 Install and test of given Compressor. LLO 5.4 Follow safety precautions.	5	Troubleshoot Compressor.	2	CO1 CO3
LLO 6.1 Troubleshoot pressure control valve, pressure relief valve, pressure reducing valve, sequence valve, give their causes and suggest remedy. LLO 6.2 Troubleshoot Linear and rotary actuators give their causes and suggest remedy. LLO 6.3 Install and test of given valve and actuator. LLO 6.4 Follow safety precautions.	6	*Troubleshoot valve and actuator.	2	CO1 CO3
LLO 7.1 Develop preventive maintenance chart for hydraulic pump system. LLO 7.2 Develop preventive maintenance chart for compressor system. LLO 7.3 Develop preventive maintenance chart for valve. LLO 7.4 Develop preventive maintenance chart for actuator.	7	Prepare preventive maintenance chart, checklist for mechanical system.	2	CO1 CO3
LLO 8.1 Troubleshoot Microcontroller, give their causes and suggest remedy. LLO 8.2 Troubleshoot PLC, give their causes and suggest remedy. LLO 8.3 Install and test of given microcontroller and PLC. LLO 8.4 Follow safety precautions.	8	*Troubleshoot microcontroller and PLC.	2	CO1 CO2
LLO 9.1 Troubleshoot industrial robot. LLO 9.2 Repair/Replace minor fault in industrial robot. LLO 9.3 Follow safety precautions.	9	*Troubleshoot industrial robot.	2	CO1 CO4
LLO 10.1 Troubleshoot CNC machine. LLO 10.2 Repair/ replace minor fault in CNC machine system. LLO 10.3 Follow safety precaution.	10	*Troubleshoot CNC machine.	2	CO1 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

- Not Applicable.

Assignment

- 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	CNC lathe/milling machine 250 with standard accessories and multi controller changing facility with simulated control panel.	10
2	AC or DC servo motor (12V to 480V AC or DC), Stepper Motor (Bipolar or unipolar stepper motor from a few volts to 48V DC).	2
3	Position Sensors (Typically 5-24V DC), Velocity Sensors (Typically 5-24V DC), Pressure Sensors (Typically 5-24V DC), Torque Sensors (Typically 5-24V DC).	3
4	Gear Pump (up to 250 bar (3625 psi)), Vane Pump (up to 210 bar), Lobe Pump (up to 15 bar (217 psi)), Axial Piston Pump (up to 420 bar (6091 psi)).	4
5	pressure control valve, pressure relief valve, pressure reducing valve, sequence valve, Linear and rotary Actuator.	5,6
6	PLC kit (minimum 8 input/output) and Microcontroller kit.	8
7	Programmable robot trainer kit with standalone servo controller as well as compatible PLC interface with following features: (1) Minimum three linkages (2) Minimum four degree of freedom (3) Different mechanical end effectors (4) Various sensors (5) Compatible robot vision system for inspection.	9
8	General Tools like Adjustable Wrench (e.g., 6 inches, 10 inches), Screwdrivers, Socket Wrench Set (e.g., 1/4-inch, 3/8-inch, 1/2-inch drive), Pliers, Multimeter (Digital) Ammeter (0-25 mA), Voltmeter (0-5V, 0-10V DC). Allen Wrench (Hex Key Set- e.g., 1.5 mm, 2 mm, 3/16 inch), Hammer, Safety Glasses.	All

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

Sr.No	Unit	Unit Title	Aligned	Learning	R-	U-	A-	Total

			COs	Hours	Level	Level	Level	Marks
1	I	Fundamental of Industrial Maintenance.	CO1	2	0	0	0	0
2	II	Maintenance of Electrical and Electronic System.	CO2	2	0	0	0	0
3	III	Maintenance of mechanical system.	CO3	3	0	0	0	0
4	IV	Maintenance of industrial robot and CNC machine.	CO4	3	0	0	0	0
Grand Total				**10**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Lab. Performance, viva voce

Summative Assessment (Assessment of Learning)

- Lab. Performance, viva voce

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	2	-	2	2	-	2			
CO2	3	2	2	2	2	-	2			
CO3	3	2	2	2	2	-	2			
CO4	3	2	2	2	2	-	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	R. Keith Mobley.	Maintenance Fundamental	Elsevier Butterworth–Heinemann ISBN: 0750677988, Year 2020.
2	Majumdar S. R.	Oil Hydraulic System- principles and Maintenance.	Tata Mc Graw Hill, ISBN: 9780074637487, Year 2018.
3	Majumdar S. R.	Pneumatic System- principles and Maintenance.	Tata Mc Graw Hill, ISBN: 9780074637487, Year 2017.

Sr.No	Author	Title	Publisher with ISBN Number
4	Madhvi Gupta.	Installation Maintenance and Repair of Electrical Machines and Equipment's.	S.K. Kataria & Sons, ISBN: 9789350145463, Year -2019.
5	Dr. R.S. Khandpur.	TROUBLESHOOTING ELECTRONIC EQUIPMENT: Includes Repair and Maintenance.	McGraw-Hill Education (India) Private Limited, ISBN: 9780070483576, Year-2019.
6	Mark R. Miller, Rex Miller.	Robots and Robotics: Principles, Systems, and Industrial Applications.	McGraw-Hill Education, ISBN: 9781259859786, Year 2017.

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://youtu.be/f58SW0Hwcf0	Maintenance System
2	https://youtu.be/SR47RaA1Zdk	Hydraulic and pneumatic system.
3	https://youtu.be/nE1C4ghfvac?list=PLgMDNELGJ1CbufZjqWa8uoSlQWKqVwPN7	Sensor and Actuator
4	https://youtu.be/Tp724MqrosA	Stepper motor
5	https://youtu.be/ditS0a28Sko	Servo motor

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	**: 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				
				Actual Contact Hrs./ Week	SLH	NLH		Paper Duration	Theory	Based on LL & TL	Based on SL	Total Marks

				CL	TL	LL					Practical											
											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) Cc- To HoD/Mentor

Name of the Institute:

with Seal

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			

MECHATRONICS SYSTEMS USING IOT **Course Code : 315365**

Programme Name/s : **Mechatronics**
Programme Code : **MK**
Semester : **Fifth**
Course Title : **MECHATRONICS SYSTEMS USING IOT**
Course Code : **315365**

I. RATIONALE

The course aims to provide with a strong foundation in the principles and technologies of Mechatronics Systems and Internet of Things (IoT), enabling them to create more efficient, innovative, and adaptable systems for a wide range of industrial applications. IoT enables real-time data collection, connectivity and automation across industrial processes to enhance efficiency and decision-making.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Develop IoT-enabled mechatronics systems to improve industrial processes, efficiency, and product quality.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Use different blocks of IoT systems.
- CO2 - Select hardware and IoT components for mechatronics Systems.
- CO3 - Integrate IoT hardware and components for given mechatronics Systems.
- CO4 - Apply different platforms and their interfacing for various Systems.
- CO5 - Develop applications of IoT using various hardware components and platforms.

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	
315365	MECHATRONICS SYSTEMS USING IOT	MIT	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 Identify different characteristics of IoT Systems. TLO 1.2 Choose Physical and logical design of IoT. TLO 1.3 Compare different technologies used in IoT TLO 1.4 Select IoT enabling technologies. TLO 1.5 Select relevant deployment levels.	**Unit - I Introduction to Internet of Things (IoT)** 1.1 Introduction to IoT 1.2 IoT characteristics 1.3 Physical design of IoT: Things in IoT, IoT Protocols 1.4 Logical design of IoT: IoT Fundamental blocks, IoT Communication Model, IoT Communication API's 1.5 IoT Enabling Technologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems 1.6 IoT Levels and Deployment templates — IoT Level-1, IoT Level-2, IoT Level-3, IoT Level-4, IoT Level-5, IoT Level-6	Lecture Using Chalk-Board Video Demonstrations Presentations
2	TLO 2.1 Select relevant sensor for the given application. TLO 2.2 Describe different input and output pins of the sensors. TLO 2.3 Identify relevant magnet relays and switches. TLO 2.4 Select relevant middleware for given IoT Systems.	**Unit - II Sensors and Hardware Platforms** 2.1 Sensors and its different parameters sensed by sensor: Light, Water detector, PIR Sensor, IR Sensor, Touch Sensor, Color Sensor, Tilt Sensor, Smoke Sensor, Gas and Alcohol Sensor. 2.2 Input and output pins of sensors, Magnet relays and switches 2.3 Middleware: M2M, RFID, WSN, SCADA	Lecture Using Chalk-Board Video Demonstrations Presentations
3	TLO 3.1 Choose relevant methodology for designing and Integration of given IoT Systems. TLO 3.2 Select relevant methods to deploy IoT application. TLO 3.3 Select logical designing for different applications. TLO 3.4 Identify different protocols for IoT Systems.	**Unit - III Design and Development of IoT Systems** 3.1 IoT Design Methodology: Purpose and requirement specification, Process specification, Domain model specification, Information model specification, Service specification, IoT level specification. 3.2 Device and component integration, Functional view specification, Operational view specification. 3.3 Logical Designing using programming language, application development. 3.4 Interface with Hardware. 3.5 Protocols - The Open Systems Interconnection (OSI) model.	Lecture Using Chalk-Board Video Demonstrations Presentations
4	TLO 4.1 Identify different IoT physical devices. TLO 4.2 Select relevant cloud base platforms for given IoT	**Unit - IV IoT Physical Device and End Point** 4.1 Architecture of Physical Devices: Arduino, Raspberry Pi, Intel Galileo, Tibbo project systems. 4.2 Cloud base IoT platforms and other open-source	Lecture Using Chalk-Board 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.
	System. TLO 4.3 Select configuration and interfacing platforms for the given IoT systems.	platforms. 4.3 Configuration of hardware platform. 4.4 Interfacing of Arduino, Raspberry Pi.	Presentations
5	TLO 5.1 Identify different home automation systems. TLO 5.2 Write steps to build IoT system to monitor air quality. TLO 5.3 Write steps to build IoT system to monitor climate for agriculture. TLO 5.4 Write steps to develop given health monitoring system.	**Unit - V IoT Applications** 5.1 Home automation: Controlling the lights, Smart Lock. 5.2 Environment and Agriculture: Air quality management, Climate Monitoring for agriculture. 5.3 Health: Heart rate monitoring system, Pulse Oximeter System.	Lecture Using Chalk-Board Video Demonstrations 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 Use USB cables, Wires, Power Supply Units, Transistors, Breadboards, Relay to design IoT systems. LLO 1.2 Operate Multimeter, Tester, Soldering Kit, Wire cutter, Hot glue gun and other components required for designing of IoT. LLO 1.3 Select various Components for designing IoT Systems.	1	*Components for IoT Systems.	2	CO1
LLO 2.1 Operate various components used in open-source prototype board and various microcontroller used in your lab.	2	Components used in open-source prototype board and microcontroller.	2	CO1
LLO 3.1 Use different sensors with given microcontroller to design IoT Systems.	3	*Sensors integration with microcontroller using breadboard	2	CO2
LLO 4.1 Design a range of LED patterns and control mechanism for various IoT applications.	4	Program to display various patterns using LED.	2	CO2
LLO 5.1 Use various shields (Ethernet and Wi-Fi networking, Bluetooth, GSM cellular networking, motor control, RFID, audio, SD Card memory, GPS, sensors, color LCD screens, and more). LLO 5.2 Determine various performance parameters for shield and breakouts.	5	*Shield interface with controller for obtaining performance of particular shield and breakouts.	2	CO3
LLO 6.1 Build smart application using microcontroller and shields or breakouts.	6	Smart System application using microcontroller and shields or breakouts.	2	CO3
LLO 7.1 Use various protocols for IoT device communication.	7	Protocols for IoT device communication.	2	CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 7.2 Design application using different types protocols used in IoT communication.				
LLO 8.1 Use various platforms for designing IoT Applications. LLO 8.2 Design application using any platform for 4 Digit 7 segment LED display.	8	*Platforms for designing IoT Applications.	2	CO4
LLO 9.1 Design application using Arduino or Raspberry-Pi for Smart Street light system.	9	Smart applications using Arduino or Raspberry-Pi.	2	CO4
LLO 10.1 Use Raspberry pi for stepper motor control. LLO 10.2 Build any application using Raspberry-Pi and stepper motor.	10	*Stepper motor control using Raspberry pi for any one application.	2	CO5
LLO 11.1 Develop smart applications using IoT.	11	Application for home or agriculture automation.	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) : NOT APPLICABLE

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Sensors: Temperature, Light, Ultra-Sonic, Humidity, Water Detector, PIR sensor, Pressure Sensor. IR sensor, Touch Sensor, Color Sensor, Humidity Sensor, Tilt Sensor, Flow and Level Sensor, Smoke, Gas and Alcohol Sensor	3,4,5,6,7,8,9,10,11
2	Arduino, Raspberry pi, Any Open-Source Prototype Board Available in Market	3,4,5,6,7,8,9,10,11
3	Shields: Ethernet and Wi-Fi networking, Bluetooth, GSM cellular networking, motor control, RFID, Audio, SD Card memory, GPS, sensors, color LCD screens	5,6,7,8,9,10,11
4	USB cables, wires, power supply units, transistors, breadboards, relay, Multimeter, Tester, Soldering Kit, wire cutter, Hot glue gun. seven-segment LED, Stepper Motor.	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 Internet of Things (IoT)	CO1	6	2	4	6	12
2	II	Sensors and Hardware Platforms	CO2	6	2	4	6	12
3	III	Design and Development of IoT Systems	CO3	12	4	6	8	18
4	IV	IoT Physical Device and End Point	CO4	8	2	4	8	14
5	V	IoT Applications	CO5	8	2	4	8	14
Grand Total				**40**	**12**	**22**	**36**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Test
- Term work

Summative Assessment (Assessment of Learning)

- Theory
- Practical

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	-	-	2			
CO2	3	2	2	3	2	-	3			
CO3	2	2	3	3	2	-	2			
CO4	3	1	2	2	1	-	2			
CO5	3	3	3	3	2	3	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	Arshdeep Bahga, Vijay Madisetti	Internet of Things: A Hands-On Approach	University Pres, ISBN: 9788173719547,1st Edition, Year: 2015
2	Adrin McEwen & Hakim Cassimality	Designing the Internet of things	Wiley India, Ltd, ISBN: 9781118430620, 1st Edition, Year:2013
3	Honobo Zhou	The internet of things in the cloud : a middleware perspective	CRC Press Taylor & Francis Group, ISBN: 9781439893029, Year:2019
4	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry	IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things	Cisco Press, ISBN: 9781587144561, 1st Edition, Year: 2017

Sr.No	Author	Title	Publisher with ISBN Number
5	Richard Blum	Sams Teach Yourself Arduino™ Programming in 24 Hours	Pearson Education, Inc., ISBN: 9780672337123, 1st Edition, Year: 2014
6	Sean McManus, Mike Cook	Raspberry Pi For Dummies	Wiley India, ISBN: 9781119796824, 4th Edition, Year: 2021

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://intersog.com/blog/development/iot-platforms-overview -arduino-raspberry-pi-intel-galileo-and-others/	IoT Platforms Overview: Arduino, Raspberry Pi, Intel Galileo and Others
2	https://www.guru99.com/iot-tutorial.html	IoT Tutorial: Introduction to Internet of Things (IoT Basics)
3	https://docs.arduino.cc/tutorials/	Tutorials - Arduino Documentation
4	https://azure.microsoft.com/en-in/solutions/iot/iot-technolo gy-protocols	IoT Protocols - The Open Systems Interconnection (OSI) model
5	https://nevonprojects.com/iot-projects/	All IOT Projects List

Note :

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

PROCESS ENGINEERING **Course Code : 315366**

Programme Name/s : **Mechatronics/ Production Engineering**
Programme Code : **MK/ PG**
Semester : **Fifth**
Course Title : **PROCESS ENGINEERING**
Course Code : **315366**

I. RATIONALE

Process engineering is the intermediate stage between design and manufacturing of a component. This course focus on the planning, design, development, operations and control of manufacturing processes in an industry. A diploma engineer should understand basic concepts and apply advanced tools and techniques employed in the field of process engineering, so as to achieve the best possible planning and control in a manufacturing environment with continuous improvements.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Prepare process plan sheet for manufacturing of components.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Evaluate a product using various criteria.
- CO2 - Prepare bill of material for a given assembly.
- CO3 - Prepare process plan for a given engineering component.
- CO4 - Construct a part family using group technology.
- CO5 - Select relevant CAPP system for a given engineering component.

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	
315366	PROCESS ENGINEERING	PEN	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 Describe procedure of design for manufacturing and assembly. TLO 1.2 Analyze various criteria for the given product. TLO 1.3 Explain functions of process engineering department. TLO 1.4 Prepare organizational flow chart for the development of process plans.	**Unit - I Introduction to Product engineering and Process engineering** 1.1 Functions of product engineering department 1.2 Design for Manufacturing and Assembly (DFMA): Definition, Procedure, Guidelines 1.3 Criteria for product analysis (aesthetics, cost, environment, safety, function, material, ergonomics) 1.4 Functions of process engineering department 1.5 Organizational flow chart for development of process plans	Lecture Using Chalk-Board Presentations Video Demonstrations
2	TLO 2.1 Analyze the given assembly using dimensional tolerance stack up methods. TLO 2.2 Select relevant surface finish roughness grade for the given operation. TLO 2.3 Explain bill of materials. TLO 2.4 Select appropriate inspection method for the given component.	**Unit - II Interpretation of part drawing** 2.1 Dimensional tolerance: Tolerance Stack up analysis (Worst case scenario analysis, Statistical analysis), ISO 2768-1: General tolerances values 2.2 Surface Finish: Three elements of surface finish, Surface finish symbols, Roughness grade numbers and it's finish marks 2.3 Bill of materials (BOM): Define, Importance of BOM, Types of BOM (Engineering BOM, Manufacturing BOM) 2.4 Inspection methods: Need of inspection methods, Types of inspection (based on timing, based on place, based on contact, based on number of samples inspected, based on application)	Lecture Using Chalk-Board Presentations Video Demonstrations
3	TLO 3.1 Describe process planning procedure. TLO 3.2 Identify the factors affecting make or buy decision during process planning for the given component. TLO 3.3 Choose a specific process for manufacturing of the given component. TLO 3.4 Prepare process flow chart for manufacturing of the given component. TLO 3.5 Explain machine and tool selection procedure. TLO 3.6 Specify different	**Unit - III Process planning** 3.1 Information required to do process planning 3.2 Process planning procedure: Make or Buy Design- factors affecting make or buy decision 3.3 Process selection procedure 3.4 Process analysis: Process flow chart 3.5 Machine and tool selection procedure 3.6 Process plan: Operation sheet and Route sheet	Lecture Using Chalk-Board Presentations Video Demonstrations 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.
	manufacturing parameters for the preparation of operation sheet and route sheet.		
4	TLO 4.1 Identify different applications of group technology. TLO 4.2 Differentiate between functional layout and group layout. TLO 4.3 Select various methods for construction of a part family for the set of similar components.	**Unit - IV Group Technology** 4.1 Introduction to Group technology, definitions and applications 4.2 Functional layout and group layout 4.3 Part family construction methods: Visual method, Production flow analysis 4.4 Basic requirement for part family coding system	Lecture Using Chalk-Board Presentations Video Demonstrations
5	TLO 5.1 Draw framework of computer aided process planning. TLO 5.2 Compare types of CAPP systems for given set of criteria. TLO 5.3 Justify role of CAPP in implementation of CIM. TLO 5.4 Describe contribution of artificial intelligence in process planning.	**Unit - V Automation in process planning** 5.1 Framework of computer aided process planning 5.2 Types of CAPP: Generative type and Variant type 5.3 CAPP software systems available in market, programming language used in CAPP software systems 5.4 Contribution of CAPP to CIM 5.5 Artificial intelligence in process planning	Lecture Using Chalk-Board Presentations Case Study Flipped Classroom

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 Measure dimensions of the given component. (e.g. Cotter key or Knuckle pin or square / hexagonal headed bolt/ nut) LLO 1.2 Create CAD model of the given component. (e.g. Cotter key or Knuckle pin or square / hexagonal headed bolt/ nut)	1	Measurement and CAD modelling of the given component.	2	CO1
LLO 2.1 Collect the given job from your institute workshop. LLO 2.2 Perform product analysis on the given job using various criteria.	2	* Analysis of the given job using various criteria.	2	CO1
LLO 3.1 List down different components of lathe machine tool post available in your institute workshop. LLO 3.2 Prepare Bill of material for the lathe machine tool post.	3	* Preparation of Bill of material for the given assembly.	2	CO2
LLO 4.1 Identify different standards for selection of dimensional tolerance values. LLO 4.2 Collect samples of industrial drawings of the components from nearest workshop. LLO 4.3 Prepare dimensional tolerance chart for the given industrial drawing using standard ISO	4	Preparation of dimensional tolerance chart for the given industrial drawing of component.	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
2768-1.				
LLO 5.1 Collect samples of industrial drawings of the components from nearest workshop. LLO 5.2 Prepare operation sheet for the given component. LLO 5.3 Prepare route sheet for the given component.	5	* Preparation of operation sheet and route sheet for the given component.	2	CO3
LLO 6.1 Identify the job to be machined on lathe. LLO 6.2 Select manufacturing process parameters for the given job by using production technology handbook.	6	Selection of manufacturing process parameters by using production technology handbook.	2	CO3
LLO 7.1 Prepare process flow chart for manufacturing of the given component. (e.g. nut/bolt/knuckle pin/cotter key,etc)	7	Preparation of process flow chart for manufacturing of the given component.	2	CO3
LLO 8.1 Perform production flow analysis to create part family for the given set of similar components.	8	* Design part family using group technology methods.	2	CO4
LLO 9.1 Prepare machining parameters table for the given component using CAPP software. (speed, feed, depth of cut, machining time,etc)	9	* Prepare a machining parameters table using CAPP software	2	CO5
LLO 10.1 Generate a process plan sheet for the given component using CAPP software.	10	Generation of a process plan sheet using CAPP software.	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) : NOT APPLICABLE

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Measuring Instruments: - Digital Vernier Caliper (Resolution 0.1 mm, Measuring Range 0-150 mm), Screw pitch gauge(52 Leaves , Narrow design, 4 to 62 TPI, 0.25 to 6.0 mm thread), Profile projector(Light axis: Vertical, Workstage size: 410 x 310 mm, Measuring range: 100 x 100 mm)	1
2	2D CAD software	1
3	Sample industrial assembly and part drawings	2,3,4,5
4	Process plan CAPP software	9,10

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

PROCESS ENGINEERING **Course Code : 315366**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to Product engineering and Process engineering	CO1	6	4	4	4	12
2	II	Interpretation of part drawing	CO2	8	4	4	6	14
3	III	Process planning	CO3	12	4	6	8	18
4	IV	Group Technology	CO4	6	2	4	6	12
5	V	Automation in process planning	CO5	8	4	4	6	14
Grand Total				**40**	**18**	**22**	**30**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two-unit tests of 30 marks and average of two-unit tests.
- For laboratory learning 25 Marks.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks.
- End semester 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	3	-	-	-	-	-	-			
CO2	3	2	2	2	-	-	-			
CO3	3	3	3	2	2	2	3			
CO4	3	2	2	-	2	-	-			
CO5	3	2	2	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	Khanna O.P.	Industrial Engineering and Management	Dhanpat Rai Publications New Delhi (2018) ISBN-13:9788189928353
2	Samuel Eilon	Production Planning and Control	Collier Macmillan Ltd New Delhi (2015) ISBN-13: 9780023318009

Sr.No	Author	Title	Publisher with ISBN Number
3	Scallan Peter	Process Planning: The Design/ Manufacture Interface	Butterworth-Heinemann (2003) ISBN-13: 9780750651295
4	Stephen N. Chapman	Fundamentals of Production Planning and Control	Pearson Education (2007) ISBN-13:9788131717394
5	Hwaiyu Geng	Manufacturing Engineering Handbook	McGraw-Hill Education (2016) ISBN-13:9780071839778

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://archive.nptel.ac.in/courses/110/105/110105155/	Automation In Production Systems and Management SWAYAM NPTEL course
2	https://archive.nptel.ac.in/courses/112/107/112107238/	Operations Management SWAYAM NPTEL course
3	https://www.youtube.com/watch?v=20_K7c65Swg	Computer aided process planning- SWAYAM NPTEL
4	https://egyankosh.ac.in/bitstream/123456789/27107/1/Unit-9.pdf	Computer aided process planning- PDF IGNOU
5	https://egyankosh.ac.in/bitstream/123456789/27217/1/Unit-1.pdf	Process planning- PDF IGNOU
6	https://egyankosh.ac.in/bitstream/123456789/27220/1/Unit-4.pdf	CAPP techniques-PDF IGNOU

Note :

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

PRODUCT DESIGN AND DEVELOPMENT **Course Code : 315367**

Programme Name/s : **Mechanical Engineering/ Mechatronics/ Production Engineering**
Programme Code : **ME/ MK/ PG**
Semester : **Fifth**
Course Title : **PRODUCT DESIGN AND DEVELOPMENT**
Course Code : **315367**

I. RATIONALE

Design and development are two key elements necessary to create any product. From start to finish, each phase of the product's lifecycle needs careful coordination between these two disciplines for a successful outcome.Each organization should come with innovative ideas to bring up a new product, to maintain a top position in the market. Product design and development is a complete cycle to launch of new industrial products i.e from conceptualization to product realization.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Use principles of product design and development for launching new products in the market.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Apply principles to develop new small industrial products according to customer's requirement for launching.
- CO2 - Use aesthetics and ergonomics principles for developing new products
- CO3 - Apply DFM principles for development of new product
- CO4 - Apply principles of QFD for Quality of new product
- CO5 - Use relevant rapid prototyping methods for development of new product along-with IPR process.

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	
315367	PRODUCT DESIGN AND DEVELOPMENT	PDD	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 Explain the criteria of customer's need identification for designing new product. TLO 1.2 Explain principles of product design TLO 1.3 Explain product development process. TLO 1.4 State concept of product development TLO 1.5 Explain Seven step method for testing of product concept with example TLO 1.6 Explain process of implementing customer need for designing new product	**Unit - I Product Development** 1.1 Characteristics of successful product development, Customer need identification 1.2 Definition of product design, principles of good product design, Design by evolution, design by innovation 1.3 Product development process, Phases of process development. flow chart of product development. Tyco product development process 1.4 Concept development- different phases of concept development process, five step concept generation method, Concept classification tree, Concept combination table 1.5 Concept selection- Concept screening, Concept scoring, Seven step method for testing of product concept 1.6 Identification of customer need, Data collection from customer, organize collected data, Establishing relative importance of customer need for designing product with example	Lecture using media Lecture using Chalk-Board
2	TLO 2.1 Define product architecture TLO 2.2 Classify Modularity TLO 2.3 List different design considerations for machine controls using ergonomics principle. TLO 2.4 Apply relevant aesthetics and ergonomics principles in given situation. . TLO 2.5 List different aspects of aesthetics in product design	**Unit - II Product Architecture** 2.1 Definition of product architecture, Modular and Integral product architecture, its types, Component standardization, Steps for establishing the architecture with example like trailer, Spanners etc 2.2 Ergonomics- definition, necessity of ergonomics in product design. Design consideration for qualitative and quantitative display, Design considerations for controls like knob, levers, handwheel, toggle switch. 2.3 Aesthetics Principles- definition, necessity of aesthetics in product design, consideration of aesthetics in product design, Aspects of Aesthetics in Product Design - form, symmetry, color, continuity, proportion, contrast, impression, surface finish	Lecture using media Model Demonstration
3	TLO 3.1 State importance of Industrial design	**Unit - III Industrial Design** 3.1 Importance of industrial design, Industrial	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.
	TLO 3.2 Explain term Design For Manufacturability (DFM) TLO 3.3 State necessity of Product Life Cycle TLO 3.4 Explain the procedure to determine 'Product Life Cycle' for given product.	design process 3.2 Design for manufacturability (DFM), steps for DFM, design principles for manufacturability , Factors affect on DFM,.Impact of DFM on cost, quality and Time 3.3 Product Life Cycle- definition, importance, stages of Product life cycle, examples for determining product life cycle of Motorcycle, electrical vehicle etc	Lecture ueing media
4	TLO 4.1 Explain term Value engineering TLO 4.2 State procedure of Problem identification related to value engineering. TLO 4.3 State importance of QFD TLO 4.4 Explain QFD with suitable example. TLO 4.5 Draw House of Quality relationship Matrix for given product.	**Unit - IV Value Engineering** 4.1 Concept, Steps in value engineering, creative thinking, problem identification and value engineering job plan (VEJP). 4.2 Quality Function deployment (QFD) process-need, importance with example, symbols of QFD, voice of customer (VOC),VOC analysis, Quality QFD relationship matrix, roof ranking, Body ranking , importance of QFD 4.3 House of Quality linking customer complaints to technical requirements	Lecture Using Chalk-Board Case Study
5	TLO 5.1 List different types of Rapid prototyping TLO 5.2 Explain working and constructions of 3-D printer. TLO 5.3 Differentiate FDM and SLA 3 - D printer TLO 5.4 Overview of Patents and IPR (Intellectual Property Right) - Importance of patent, patent rights, criteria for patent, process for filing patents. TLO 5.5 Elaborate the benefits of Patent and IPR TLO 5.6 Explain procedure for filing patent.	**Unit - V Rapid Prototyping and Patent Filing** 5.1 Rapid Prototyping- concepts, principles of rapid prototyping, Types of Rapid Prototyping- Proof of concept prototype, Looks like prototype, Works like prototype 5.2 3-D printer types – Fused deposition Modeling (FDM), Stereolithography (SLA), Selective Laser sintering (SLS), construction and working-. Comparison between different types of 3-D printer 5.3 Planning for prototyping-steps for planning for prototyping, define purpose, establish level of approximation, experimental plan, schedule for procurement, production and testing 5.4 Patents and intellectual property- Importance of patent, patent rights, criteria for patent, process for filing patents.	Lecture using Chalk-Board 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 Draw layout of Simple product evolution diagram	1	*Layout of simple product evolution diagram	2	CO1
LLO 2.1 Draw diagram of existing bench available in the classroom. LLO 2.2 Apply ergonomics principle to classroom bench	2	*Development of existing Classroom bench/ Chair/Drawing table/Laboratory table using relavant ergonomics principles.	4	CO2

PRODUCT DESIGN AND DEVELOPMENT **Course Code : 315367**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 2.3 Draw diagram of modified / developed bench using ergonomic principle.				
LLO 3.1 Draw sketch of any component available in the laboratory LLO 3.2 Apply aesthetic principles to the development of a given product. LLO 3.3 Draw sketch of modified product	3	Development of product using aspects of aesthetics in product designing	2	CO2
LLO 4.1 Select any simple product from Market LLO 4.2 Apply DFM principle for development of identified product as per requirement LLO 4.3 Write a report of identified product using DFM	4	Draw flow chart for accepting design of new product using DFM principle	2	CO3
LLO 5.1 Collect specification of bicycle using manufacturer's catalogue. LLO 5.2 Determine product life cycle of identified bicycle LLO 5.3 Draw product life cycle diagram of identified bicycle	5	*Determination of product life cycle of Bicycle	2	CO2 CO3
LLO 6.1 Draw Roof and Body of House of Quality. LLO 6.2 Prepare questionnaire for customers/users to know technical requirements. LLO 6.3 Apply principles of QFD for drawing House of Quality. LLO 6.4 Draw House of Quality diagram for given product	6	*Build House of Quality for steel cupboard / computer bench/ furniture available in the laboratory	4	CO1 CO4
LLO 7.1 Draw diagram of developed product LLO 7.2 Produce prototype of developed product	7	Development of prototype of any simple object using cardboard/plywood etc	2	CO1 CO2 CO5
LLO 8.1 Draw flow chart for filing a patent using Governemnt website	8	* Draw flow chart for filing patent (IPR act 2005)for given product usiing Government of India website.	2	CO5
LLO 9.1 Develop model using solid modeling software	9	Use of 3-D printer	4	CO1 CO5
LLO 10.1 Draw diagram of identified product LLO 10.2 Produce prototype of identified product	10	Development of prototype of any identified product from the market	2	CO1 CO2 CO5

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs

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)

Activity based on voice of customer

- Prepare a brief report based on voice of customer through survey

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	3 D printer (FDM)- size- 200x200x250 mm, layer resolution 0.08 mmto 0.4 mm,print speed 40-120 mm/sec,Nozzle size 0.4mm,Filament- ABS/PLA/Composit	12,13
2	Computer systems and peripherials-2GB RAM,CPU1GHz,Disk Space-1.2 GB for 64 bit platform,OS ,minimum .single core ,Graphic card, sound card	All
3	Solid Modeling software such as Creo,Solid Edge, Solid works or equivalent	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	Product Development	CO1	9	4	4	8	16
2	II	Product Architecture	CO2	6	2	4	6	12
3	III	Industrial Design	CO3	9	4	4	8	16
4	IV	Value Engineering	CO4	10	4	4	8	16
5	V	Rapid Prototyping and Patent Filing	CO5	6	2	2	6	10

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Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
Grand Total				40	16	18	36	70

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Mid term tests Rubrics for COs Assignment, Self-learning and Terms work Seminar/Presentation

Summative Assessment (Assessment of Learning)

- End of Term Examination Viva-voce Lab. performance

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	-	2	2	3			
CO2	-	-	3	-	2	3	3			
CO3	-	2	-	-	2	2	3			
CO4	-	2	2	-	-	3	3			
CO5	-	-	-	2	2	3	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	K.T.Ulrich	Product Design and Development	6th edition, McGrawhill Publication, 2023 ISBN 9780071086950
2	A.K.Chitale, R.C.Gupta	Product Design and Manufacturing	7th edition, PHI publication 2023, ISBN-13-978-9391818722
3	Richard Morris	Fundamentals of Product Design	2nd edition,2023, Bloomsbury Visual Arts Publication, ISBN 13- 978-1350398856
4	M.M.Soreas	Ergonomics in Design	1st edition,2016 CRC Press Publication, ISBN13-978-0367356903

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://archive.nptel.ac.in/courses/112/107/112107217/	NPTEL lecture on product design steps and

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Sr.No	Link / Portal	Description
		analysis
2	https://www.youtube.com/watch?v=mqC4Wn_OK-I	Value engineering
3	https://archive.nptel.ac.in/courses/112/107/112107217/	NPTEL Lecture on Ergonomics for Product Design
4	https://archive.nptel.ac.in/courses/112/107/112107217/	NPTEL Lecture on QFD
5	https://archive.nptel.ac.in/courses/112/107/112107217/	NPTEL Lecture on Functional Analysis Technique
6	https://archive.nptel.ac.in/courses/112/107/112107217/	NPTEL Lecture on Rapid Prototyping
7	https://archive.nptel.ac.in/courses/112/107/112107217/	NPTEL Lecture on Rapid Prototyping Processes
8	https://www.youtube.com/watch?v=dYPW5Rlwn8g	Working of 3 D printer
9	https://archive.nptel.ac.in/courses/112/107/112107217/	NPTEL lecture on product life cycle
10	https://www.youtube.com/watch?v=X1KONQw02H8	Quality of House
11	https://www.youtube.com/watch?v=Lo-AFCv2ggE	Product design and development
12	https://onlinecourses.nptel.ac.in/noc21_me83/preview	NPTEL lecture on product design and development
13	https://www.youtube.com/watch?v=iRMsd-X_e-0	QFD Analysis
14	https://archive.nptel.ac.in/courses/112/107/112107217/	NPTEL Lecture on VEJP
15	https://archive.nptel.ac.in/courses/112/107/112107217/	NPTEL lecture on Value engineering Concepts

Note :

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