Maharashtra State Board Of Technical Education, Mumbai

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

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

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Assessment Scheme											
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week		Paper Duration (hrs.)	Theory				Based on LL & TL				Based on Self Learning		Total Marks
																	Practical						
						CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
													Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
(All Compulsory)																							
1	EMERGING TRENDS IN MECHANICAL ENGINEERING	ETM	DSC	315363	-	3	-	-	-	3	1	1.5	30	70*#	100	40	-	-	-	-	-	-	100
2	POWER ENGINEERING	PER	DSC	315371	1	5	-	4	3	12	4	3	30	70	100	40	25	10	25#	10	25	10	175
3	AUTOMOBILE ENGINEERING	AEN	DSC	315372	1	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150
4	SEMINAR AND PROJECT INITIATION COURSE	SPI	AEC	315003	-	-	-	1	2	3	1	-	-	-	-	-	25	10	25@	10	25	10	75
5	INTERNSHIP(12 WEEKS)	ITR	INP	315004	-	-	-	-	-	36 - 40	10	-	-	-	-	-	100	40	100#	40	-	-	200
Elective - I (Any - One)																							
6	PRODUCT DESIGN AND DEVELOPMENT	PDD	DSE	315367	-	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150
	HEATING VENTILATION AIR CONDITIONING	HVA	DSE	315373	2	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150
	POWER PLANT ENGINEERING	PPE	DSE	315374	-	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150
Total					**4**	**16**		**9**	**5**		**20**		**120**	**280**	**400**		**200**		**200**		**50**		**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												
				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	
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
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 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

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Explain 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 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).	**Unit - IV Recent Trends in Maintenance** 4.1 Autonomous Maintenance: Concept, Pillars of 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).	Lecture Using Chalk-Board 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
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 TPM on the Shop Floor	1st Edition, Productivity Press, ISBN-13: 978-0367199869
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

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

Sr.No	Link / Portal	Description
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
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

POWER ENGINEERING **Course Code : 315371**

Programme Name/s : **Mechanical Engineering**
Programme Code : **ME**
Semester : **Fifth**
Course Title : **POWER ENGINEERING**
Course Code : **315371**

I. RATIONALE

The diploma holders in Mechanical Engineering are mainly responsible for supervising, testing, and maintenance of power engineering devices. The knowledge of power engineering is useful in selecting a suitable prime mover for a given application along with maintaining and testing of these devices. Therefore, the knowledge and skills covering the basic principles of power engineering devices are necessary for mechanical diploma engineers. In view of the requirements, this course is designed to establish basic fundamental and practical knowledge in the fields of I.C. engines, air compressors, refrigeration & air conditioning, and energy-saving opportunities in air compressor and refrigeration & air conditioning systems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Maintain power engineering and refrigeration devices for various industrial / field applications using relevant knowledge & skills related to power engineering.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Assess the performance of given refrigeration systems.
- CO2 - Measure the cooling capacity of air-conditioning systems.
- CO3 - Carryout test for the performance of an I.C. engine.
- CO4 - Analyze the performance of air compressor.
- CO5 - Use the knowledge of energy saving in air compressor & refrigeration and air-conditioning 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		
315371	POWER ENGINEERING	PER	DSC	5	-	4	3	12	4	3	30	70	100	40	25	10	25#	10	25	10	175	

Total IKS Hrs for Sem. : 1 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 Draw Carnot and Bell Coleman cycle on P-V & T-S diagram. TLO 1.2 Calculate the COP of the given vapor compression cycle. TLO 1.3 Illustrate the working of the vapor absorption refrigeration system. TLO 1.4 Select relevant refrigerant for a given application with justification TLO 1.5 Explain with a neat sketch working of a domestic refrigerator, water cooler, ice plant & cold storage. TLO 1.6 Compare traditional methods of cooling with the recent cooling process.	**Unit - I Refrigeration** 1.1 Definition of refrigeration, refrigeration effect, unit of refrigeration, coefficient of performance, air refrigeration, reverse Carnot cycle, Bell – Coleman cycle & its representation on P-V & T-S diagram. 1.2 Vapor Compression Refrigeration Systems (VCRS) : Basic components, flow diagram of the vapor compression cycle, working of VCRS, representation of the vapor compression cycle on P-H & T-S diagram, sub cooling and superheating, expression for refrigerating effect, work done and power required, coefficient of performance COP. (Simple numerical on VCRS) 1.3 Vapor Absorption Refrigeration System (VARS) : Principle of vapor absorption refrigeration system, basic components, construction and working of simple vapor absorption refrigeration system, comparison of VCRS and VARS. (No numerical on VARS) 1.4 Refrigerants : Definition, desirable properties of refrigerant, primary and secondary refrigerant, selection of refrigerant, concept of Global Warming Potential (GWP) , Ozone Depletion Potential (ODP). 1.5 Applications : Specification, construction and working of refrigerator, water cooler, ice plant, and cold storage. 1.6 Traditional methods of cooling used in ancient India (IKS). (No question to be asked)	Lecture Using Chalk-Board Presentations Model Demonstration 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.
2	TLO 2.1 Classify air conditioning systems. TLO 2.2 Determine properties of air using a psychrometric chart for given application. TLO 2.3 Represent psychrometric processes on psychrometric chart. TLO 2.4 Explain with a neat sketch working of 2/4-way ceiling mounted cassette air conditioner.	**Unit - II Air Conditioning** 2.1 Air conditioning : Definition, factors affecting comfort air conditioning, classification of air conditioning systems, comfort air conditioning and industrial air conditioning. 2.2 Psychrometry : Definition of dry air, moist air, saturated air, dry bulb temperature, wet bulb temperature, dew point temperature, absolute humidity, relative humidity, specific humidity, enthalpy of moist air. Psychrometric chart, use of psychrometric chart. 2.3 Psychrometric Processes : Sensible heating, sensible cooling, humification, dehumidification, heating and humidification, heating and dehumidification, cooling and humidification, cooling and dehumidification. Representation of the above process on a psychrometric chart. Sling psychrometer. (Simple numerical using psychrometric charts and tables) 2.4 Applications : Construction and working of window air conditioner, split air conditioner, 2/4-way ceiling mounted cassette air conditioner.	Lecture Using Chalk-Board Presentations Model Demonstration Video Demonstrations
3	TLO 3.1 Calculate the performance parameters of the given I.C. engine. TLO 3.2 Explain the procedure to calculate the indicated power of the given engine using the morse test. TLO 3.3 Explain with neat sketch working of catalytic converter to control the emissions from the I.C engine. TLO 3.4 Illustrate the diagnostic procedure of the Engine Control Unit with flow diagram.	**Unit - III I.C Engine Testing and Pollution Control** 3.1 Purpose of I.C. engine testing, I.C. engine testing norms. Definition & measurement of performance parameters like brake power, indicated power, frictional power, brake and indicated mean effective pressures, brake specific fuel consumption, brake thermal efficiency, indicated thermal efficiency, mechanical efficiency, and relative efficiency. Morse test, heat Balance sheet, (Simple numerical on the performance of I.C. engines, morse test & heat balance sheet) 3.2 Polluting emissions in S.I. & C.I engines and their effects on the environment. Controlling methods : Catalytic converters, Exhaust Gas Recirculation (EGR) . Standard pollution norms like EURO IV & VI, BS-VI. Engine Control Unit (ECU) : Working and Diagnostic procedure.	Lecture Using Chalk-Board Presentations Video Demonstrations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Classify air compressors. TLO 4.2 Explain the construction and working of single-stage & two-stage reciprocating air compressors. TLO 4.3 Calculate the performance parameters of the given compressor. TLO 4.4 Select relevant air compressor for the given application with justification.	**Unit - IV Air Compressors** 4.1 Function of air compressor, uses of compressed air, classification of air compressors. Construction and working of single-stage and two-stage reciprocating air compressors, screw compressor, centrifugal compressor, axial flow compressor. Comparison of rotary compressor with reciprocating air compressor. 4.2 Necessity of multi-staging, advantages of multi-staging, intercooling, representation of processes involved on P-V diagram, calculation of work done. 4.3 Specifications of air compressors, pressure ratio, compressor capacity, free air delivered, volumetric efficiency, isothermal efficiency. (Simple numerical on reciprocating air compressor)	Lecture Using Chalk-Board Presentations Video Demonstrations
5	TLO 5.1 List the different components of a compressed air system. TLO 5.2 Elaborate the energy saving opportunities in compressed air systems. TLO 5.3 List the factors affecting the performance and energy efficiency of refrigeration and air conditioning systems. TLO 5.4 Explain the energy saving opportunities in refrigeration and air conditioning systems.	**Unit - V Energy Efficiency in Air Compressor & Refrigeration and Air Conditioning** 5.1 Air Compressor : Compressed air system components, need of energy management in compressed air systems, factors affecting efficient operation of compressed air systems, checklist for energy efficiency in compressed air systems. 5.2 Refrigeration & Air conditioning : Factors affecting performance and energy efficiency of refrigeration and air conditioning system, energy saving opportunities in refrigeration and air conditioning system.	Lecture Using Chalk-Board Presentations Video Demonstrations Site/Industry 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 Prepare a schematic diagram showing the various components of a domestic refrigerator. LLO 1.2 Prepare a sketch of flow- path of refrigerant.	1	Trace the flow of refrigerant through various components of the domestic refrigerator.	2	CO1
LLO 2.1 Perform the test using vapor compression refrigeration test rig to measure the various parameters like temperature, pressure, etc. LLO 2.2 Calculate the COP of the system.	2	*Test on vapor compression refrigeration test rig.	2	CO1

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 3.1 Select the proper tools for dismantling/assembling. LLO 3.2 Perform the dismantling /assembling of given water cooler by following proper sequence.	3	Assemble / Dismantle various components of water cooler.	2	CO1
LLO 4.1 Measure air properties of conditioned air such as dry bulb temperature, wet bulb temperature using a sling psychrometer.	4	*Use of sling psychrometer.	2	CO2
LLO 5.1 Select the proper tools for dismantling/assembling. LLO 5.2 Perform the dismantling /assembling of given window air conditioner by following proper sequence.	5	Assemble / Dismantle various components of window air conditioner.	2	CO2
LLO 6.1 Perform a test using a window air conditioner to measure temperature, pressure, mass flow rate etc. LLO 6.2 Perform a test using a window air conditioner to determine its COP.	6	*Test on window air conditioner.	2	CO2
LLO 7.1 Measure the input current, voltage, working pressure and temperature by using appropriate measuring instruments. LLO 7.2 Diagnose the faults in the given air-conditioning system.	7	Demonstration of split air conditioner.	2	CO2
LLO 8.1 Perform the test using air conditioning test rig to measure the various parameters like temperature, pressure, mass flow rate of air etc. LLO 8.2 Calculate the COP and cooling capacity of the given air conditioning system.	8	Test on air conditioning test rig.	2	CO2
LLO 9.1 Select proper instrument to conduct a test. LLO 9.2 Measure the various parameters like temperature, pressure, fuel consumption, water flow rate, using I.C. engine test rig.	9	*Demonstration of I.C. engine test rig.	2	CO3
LLO 10.1 Calculate the various parameters like Brake power, Frictional power, and Mechanical efficiency. LLO 10.2 Draw the performance curves.	10	*Test on I.C. engine test rig Part – I	2	CO3
LLO 11.1 Perform the test using I.C. engine test rig to measure the various parameters like temperature, pressure, fuel consumption, water flow rate, etc. LLO 11.2 Prepare a heat balance sheet.	11	*Test on I.C. engine test rig Part – II	2	CO3
LLO 12.1 Measure the speed & load by using tachometer & dynamometer. LLO 12.2 Determine indicated power and mechanical efficiency.	12	*Morse Test on I.C. engine test rig.	2	CO3
LLO 13.1 Measure various pollutants in the S.I. engine. LLO 13.2 Analyze pollutants in the given S.I. engine.	13	Use of exhaust gas analyzer for S.I. engine.	2	CO3
LLO 14.1 Measure various pollutants in the C.I. engine. LLO 14.2 Analyze pollutants in the given C.I. engine.	14	Use of exhaust gas analyzer for C.I. engine.	2	CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 15.1 Interpret the notation code on the dashboard and monitor of the computer. LLO 15.2 Diagnose the faults in given I.C. engine. LLO 15.3 Suggest the remedies over the faults detected.	15	Diagnosis test on I.C. engine using engine control unit.	2	CO3
LLO 16.1 Perform the test using two stage reciprocating air compressor test rig to measure the various parameters like temperature, pressure, air flow rate, etc. LLO 16.2 Determine actual volume of free air delivered.	16	*Test on two-stage reciprocating air compressor Part I	2	CO4
LLO 17.1 Calculate pressure ratio, volumetric efficiency & thermal efficiency. LLO 17.2 Draw the performance characteristics.	17	*Test on two-stage reciprocating air compressor Part II	2	CO4
LLO 18.1 Inspect the given compressed air system. LLO 18.2 Find out the sources of losses that occurred in the given compressed air system.	18	Losses in the compressed air system.	2	CO5
LLO 19.1 Inspect the air conditioning system. LLO 19.2 Prepare the checklist for energy efficiency.	19	*Energy saving in air conditioning system.	2	CO5

Note : Out of above suggestive LLOs -

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

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

Assignment

- Prepare a power point presentation on Bharat Stage & Euro emission norms for I.C. Engine.
- Make charts for performance characteristics of I.C. engine.
- Make a chart showing the heat balance sheet format to display in a laboratory.
- Collect specifications of domestic refrigerators of various air conditioners from manufacturers websites.
- Collect information on different tests used for I.C. engines.
- Prepare troubleshooting chart for domestic refrigerator/window air conditioner.
- Make a chart showing valve timing diagrams of four stroke petrol and diesel engines.
- Prepare maintenance schedule of air compressor.
- Collect information about fuel injection systems used in S.I & C.I engine.

Micro project

- Select the old parts of any rotary air compressor and mount it on a wooden board with the label and display it in laboratory.
- Collect constructional and working details of different types of reciprocating and rotary compressors.
- Collect major specifications & constructional details of different types of refrigeration and air conditioning units.
- Prepare and present a seminar on energy saving opportunities in compressed air systems using any suitable source of information.

- Prepare and present a seminar on energy saving opportunities in refrigeration and air conditioning systems using any suitable source of information.
- Collect information and pictures about ancient cooling methods from suitable sources of information.
- Display various components of Multi Point Fuel Injection (MPFI) system on wooden board with labels.
- Specifications &types of various components like compressor, condenser, air handling unit, chillers, etc.

Note :

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

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Actual working or scrap unit of a domestic refrigerator of a minimum 165 liters having all necessary parts.	1
2	Test rig of multi-cylinder I.C. Engine with 3/5/7 HP Petrol/Diesel Engine with the necessary arrangement to conduct morse test.	12
3	Exhaust gas analyzer 3/5 gas analyzer - For CO (%)-Range 0-10, For HC (ppm)- Range 0 -10000, PM-Range 0-9000.	13,14
4	Engine Control Unit (ECU),OBD II car diagnostic tool Grade II	15
5	Test rig of two-stage reciprocating air compressor with minimum ½ HP motor with necessary pressure and temperature gauges at a suitable location.	16,17,18
6	Available air conditioning system in your institute.	19
7	Vapor compression refrigeration test rig with hermitically sealed compressor ½ to ¼ HP motor, air-cooled condenser, expansion devices like TEV or capillary tube, pressure and temperature gauges at suitable locations.	2
8	Actual working or scrap unit of water cooler of minimum 200 liter capacity having all necessary parts.	3
9	Standard sling psychrometer to measure DBT and WBT.	4
10	Old cut section of window air conditioner , tool Box containing flaring tool, spanner, piercing pliers, hammer, side cutter, cordless screw driver, rounding tool etc.	5
11	Window air conditioner test rig with 1 to 2 TR cooling capacity with forced convection condenser and evaporator fitted with all necessary instrumentation.	6
12	Split air conditioner model with 1 to 2 TR capacity, Expansion Device Capillary Tube compatible capacity, Temperature Sensors RTD PT-100 Type, Air cooled condenser compatible to 1 Ton compressor	7

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
13	Air conditioning test rig with hermitically sealed compressor ½ to ¼ HP motor, air-cooled condenser, expansion devices like TEV or capillary tube, pressure and temperature gauges at suitable locations, blower unit with 1HP,3 phase motor, steam generator to generate steam with suitable piping for introducing steam in the duct- 8-liter capacity with 2 kw heater.	8
14	Test rig of single cylinder/multi cylinder I.C. Engine with 3/5/7 HP Petrol/Diesel Engine with necessary arrangement	9,10,11

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	Refrigeration	CO1	12	4	4	8	16
2	II	Air Conditioning	CO2	12	4	4	8	16
3	III	I.C Engine Testing and Pollution Control	CO3	12	4	4	8	16
4	IV	Air Compressors	CO4	9	2	4	8	14
5	V	Energy Efficiency in Air Compressor & Refrigeration and Air Conditioning	CO5	5	2	2	4	8
Grand Total				**50**	**16**	**18**	**36**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

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

Summative Assessment (Assessment of Learning)

- End semester assessment of 25 marks for laboratory learning.
- End semester assessment of 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	1	1	2	1	2			
CO2	3	2	1	1	2	1	2			

CO3	3	2	-	1	2	1	2			
CO4	3	2	-	1	2	1	2			
CO5	3	2	-	1	2	1	2			

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Mathur M.L , Sharma R. P	Internal Combustion Engines	Dhanpatrai Publication (P) Ltd , New Delhi 2018, ISBN : 9789383182428
2	V. Ganeshan	Internal Combustion Engines	Tata McGraw Hills, New Delhi, ISBN :9781259006197
3	C.P Arora	Refrigeration and Air Conditioning	Tata McGraw Hill Education, New Delhi 2021, ISBN : 9789390385843
4	Dr. Sadhu Singh	Refrigeration and Air Conditioning	Khanna Book Publication Co (P) Ltd, New Delhi 2017, ISBN : 9789386173089
5	Mahesh M. Rathore	Thermal Engineering	Tata McGraw Hill Education, New Delhi 2010, ISBN : 9780070681132
6	R.K. Rajput	Thermal Engineering	Laxmi Publications New Delhi, 2020, ISBN: 9788131808047
7	R.S.Khurmi & J.K.Gupta	A Textbook of Thermal Engineering	S.Chand Limited New Delhi 2022 , ISBN : 9789355010544
8	Bureau of Energy Efficiency	Energy Efficiency in Electrical Utilities	Bureau of Energy Efficiency, Fourth Edition 2015

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=4mWsRUr0A7A&list=PLJjrv2_3aFXdh1PQVeO1RRl_NmXiiPZh0&index=3	Introduction to Refrigeration
2	https://www.youtube.com/watch?v=QZp7LzYEMCs&list=PLJjrv2_3aFXdh1PQVeO1RRl_NmXiiPZh0&index=4	Air Refrigeration Cycle
3	https://www.youtube.com/watch?v=XO2PBDMEHfs&list=PLJjrv2_3aFXdh1PQVeO1RRl_NmXiiPZh0&index=8	Vapor Compression Cycle - 1
4	https://www.youtube.com/watch?v=urFrdSAJmyM&list=PLJjrv2_3aFXdh1PQVeO1RRl_NmXiiPZh0&index=9	Vapor Compression Cycle - 2
5	https://www.youtube.com/watch?v=4w3Obp8ILpA&list=PLJjrv2_3aFXdh1PQVeO1RRl_NmXiiPZh0&index=19	Vapor Absorption Refrigeration System
6	https://www.youtube.com/watch?v=ExNJoT_2XeI&list=PLJjrv2_3aFXdh1PQVeO1RRl_NmXiiPZh0&index=22	Introduction to Air Conditioning
7	https://www.youtube.com/watch?v=8Id1SZQpWY0&list=PLJjrv2_3aFXdh1PQVeO1RRl_NmXiiPZh0&index=23	Properties of Moist Air

POWER ENGINEERING **Course Code : 315371**

Sr.No	Link / Portal	Description
8	https://www.youtube.com/watch?v=e2IryaMQQ6A&list=PLJjrv2_3aFXdh1PQVeO1RRl_NmXiiPZh0&index=24	Psychrometric Chart
9	https://www.youtube.com/watch?v=l_3K5Hr6bB8&list=PLJjrv2_3aFXdh1PQVeO1RRl_NmXiiPZh0&index=25	Psychrometric Processes
10	https://www.youtube.com/watch?v=2chEheloWIU	Performance analysis parameters of I.C. Engine
11	https://www.youtube.com/watch?v=zH-vv5be91M	Simple tips to improve energy efficiency of your compressed air system
12	https://www.youtube.com/watch?v=CMFRJ4rGXsc	Axial flow compressor
13	https://www.youtube.com/watch?v=4JiQ5XfpwfA	Energy Savings in Compressed Air system
14	https://www.coolingindia.in/energy-conservation-in-refrigeration-hvac-system	Energy Conservation in Refrigeration & HVAC System
15	https://www.youtube.com/watch?v=zqXgmVnI3L8&list=PLE2DA184A2E479885&index=1	History of refrigeration
16	https://archive.nptel.ac.in/content/storage2/courses/112105129/pdf/RAC%20%20Lecture%201.pdf	History of refrigeration

Note :

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

AUTOMOBILE ENGINEERING **Course Code : 315372**

Programme Name/s : Mechanical Engineering
Programme Code : ME
Semester : Fifth
Course Title : AUTOMOBILE ENGINEERING
Course Code : 315372

I. RATIONALE

Diploma holders in Mechanical Engineering are expected to identify the components in automobile systems, select the different layouts as per the applications and demonstrate the working of various automobile systems. This course will be helpful to student in correlating various automobile systems with each other and provides the opportunity to work in various automobile manufacturing units , sales and service of automobiles products.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Carry out activities / tasks related to vehicle maintenance efficiently by following safe practices.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Use appropriate tools for vehicle service operation.
- CO2 - Carryout repairing activities by following laid down procedures.
- CO3 - Diagnose faults in given automobile control systems.
- CO4 - Locate faults in suspension system of given automobile.
- CO5 - Carryout appropriate test for given auto electrical and electronic components.

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		
315372	AUTOMOBILE ENGINEERING	AEN	DSC	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150	

Total IKS Hrs for Sem. : 1 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 various components of vehicle. TLO 1.2 Classify automobiles on the basis of various criteria. TLO 1.3 Draw layout of various vehicles. TLO 1.4 State the advantages and disadvantages of layout of various vehicle. TLO 1.5 State the function of chassis, frame and body. TLO 1.6 Compare conventional frame and Unitized frame. TLO 1.7 Explain with sketch the functions of various components of Electric & Hybrid vehicles.	**Unit - I Introduction to Automobile** 1.1 Automobile: Definition, Major Components of Automobiles with their functions. 1.2 Classification of Automobiles on the basis of Purpose, Load capacity, Fuels used, based on drive, no. of wheels and axles, transmission, Suspension. 1.3 Vehicle Layout: Significance of vehicle Layout, Different types of vehicle layout, Front Engine Front Wheel Drive, Front Engine Rear Wheel Drive, Rare Engine Rear Wheel Drive, Four Wheel Drive.(FEFWD, FERWD, RERWD, 4WD), Advantages and Disadvantages. 1.4 Function of Chassis, Frame and Body: Chassis components, Functions of frame, Loads acting on the frame, Advantages, disadvantages and types of frames (Conventional frame, sub-frames, unitized frame or frameless construction), Requirements of Body, different types of body styles. 1.5 Electric & Hybrid Vehicle: Needs, components and their Functions. 1.6 Development of Automobiles from Ancient time. (IKS) (No Theory question)	Video Demonstrations Presentations Model Demonstration Lecture Using Chalk-Board

AUTOMOBILE ENGINEERING **Course Code : 315372**

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.
2	TLO 2.1 Draw layout of transmission system TLO 2.2 State the necessity of clutch. TLO 2.3 Compare Single plate clutch & Multiplate clutch. TLO 2.4 Explain Single Plate clutch and Multiplate clutch with neat sketch. TLO 2.5 Explain working of various types of Gear box with sketch. TLO 2.6 State the function of propeller shaft, Universal joint and slip joint. TLO 2.7 Explain the working principle of Differential with sketch. TLO 2.8 Identify various types of axle and its components TLO 2.9 Explain with sketch Torque converter.	**Unit - II Automobile Transmission system** 2.1 Transmission System Layout, components and its application: Layout of two wheel drive transmission system (2WD) and four wheel drive transmission system (4WD) and application. 2.2 Clutch: Function and Necessity, Requirement, classification, working principle, construction and working of Single plate (Coil Spring and Diaphragm) clutch, Multiplate Clutch. 2.3 Gear Box: Manual Transmission, Classification, Construction and working of Constant Mesh Gear Box and Synchromesh Gear Box. Automatic transmission, Torque converter , Epicyclic Gearbox (Gear Train). 2.4 Propeller Shaft: Functions and Necessity, Construction of propeller shaft, Functions of universal joint and slip joint 2.5 Differential: Function and Necessity, construction and working principle. 2.6 Axle: Front axle Construction and requirements, Types of (Front) Stub axle, construction and functions of Semi floating, Fully floating type of rear axle.	Model Demonstration Video Demonstrations Lecture Using Chalk-Board Presentations
3	TLO 3.1 State the function of braking system. TLO 3.2 Explain various types of brake system with neat sketch. TLO 3.3 Explain with sketch major components of hydraulic brake systems. TLO 3.4 Compare Disc and Drum Brakes. TLO 3.5 Explain the concept of ABS. TLO 3.6 Explain Working of Steering linkages. TLO 3.7 Explain with sketch various types of steering gear boxes. TLO 3.8 Describe the terms related to steering geometry with neat sketch	**Unit - III Automobile Control Systems** 3.1 Braking System: Function and Braking Requirements, Classification of brakes. Construction and working of Drum and Disc Brakes. Working of Mechanical, Hydraulic and Air brake system. 3.2 Major Components of Hydraulic braking System: Master Cylinder, Wheel cylinder. 3.3 Antilock brake system (ABS):Introduction 3.4 Steering System: Function and Requirements, Construction of steering linkages for rigid axle and Independent suspension systems. 3.5 Steering Gear box: Types, Construction and working of Rack and pinion, Recirculating ball type steering gear box, Necessity and principle of power steering. 3.6 Steering Geometry: Castor, camber, Toe-in, Toe-out, King pin inclination, understeer and over steer.	Model Demonstration Video Demonstrations Lecture Using Chalk-Board Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Explain with neat sketch working of various type of suspension system. TLO 4.2 Compare Rigid axle and Independent Suspension. TLO 4.3 Describe working of hydraulic Shock absorber and Air Suspension system. TLO 4.4 State the types of wheel rims and it's Nomenclature. TLO 4.5 Compare Radial Ply, Cross Ply tyres. TLO 4.6 Select suitable tyres on the basis of designation. TLO 4.7 State the necessity of wheel alignment and balancing TLO 4.8 State the procedure of wheel alignment and balancing.	**Unit - IV Automobile Suspension ,wheels and tyres** 4.1 Suspension Systems: Function and Requirements , Rigid axle suspension system (Leaf Spring) construction. 4.2 Independent suspension system Introduction, Types of Independent suspension system. Construction and working of Mac-pherson strut type, wishbone type of suspension system. 4.3 Shock Absorber and Air Suspension: construction and working of Telescopic shock absorber, construction and working of Air suspension system. 4.4 Wheels, Rims and Tyres: Function and requirement of wheels. Types of wheels 4.5 Tyre cross section: Cross Ply, Radial ply and belted bias, Tyre designation, Factors affecting tyre life. 4.6 Wheel Alignment and Wheel balancing: Purpose of wheel alignment, Procedure of wheel alignment .Purpose of wheel balancing and procedure of wheel balancing.	Model Demonstration Video Demonstrations Presentations Lecture Using Chalk-Board
5	TLO 5.1 Explain battery components and working. TLO 5.2 State Battery rating and its capacity. TLO 5.3 State the function of starter and alternator. TLO 5.4 Explain the working of different types of ignition system with sketch. TLO 5.5 State various types of sensor with applications.	**Unit - V Introduction to Auto Electrical Systems** 5.1 Introduction to Battery and its components: Function and Requirements of battery, Types of battery, Battery components and working, Battery Rating and Battery Capacity. 5.2 Starting System and charging system: Functions and Requirement of starting and charging system, starting system components and their functions, Alternator components and their functions. Working Principle of alternator. 5.3 Ignition System: Introduction to various types of Ignition Systems. (Battery Ignition, Magneto Ignition and Electronic Ignition System) 5.4 Miscellaneous: Types of sensors used in Automobile .	Model Demonstration Video Demonstrations Presentations Lecture Using Chalk-Board

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

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

AUTOMOBILE ENGINEERING **Course Code : 315372**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify automobile systems like (Transmission ,Control ,Suspension ,Electrical and Electronics) LLO 1.2 Draw layout of various types of vehicles. Front Engine Front Wheel Drive, Front Engine Rear Wheel Drive, Rare Engine Rear Wheel Drive, Four Wheel Drive.(FEFWD, FERWD, RERWD, and 4WD) LLO 1.3 Compare various layouts.	1	Preparation of Layout of given Vehicle	2	CO1
LLO 2.1 Select various tools available in laboratory. LLO 2.2 Categorize tools available in laboratory.	2	*Use appropriate tools for service applications.	2	CO1
LLO 3.1 Dismantle given clutch. LLO 3.2 Identify components of clutch. LLO 3.3 Draw any components of the clutch. LLO 3.4 Identify fault in clutch. LLO 3.5 Assemble clutch.	3	*Dismantling and Assembling of Clutch.	2	CO2
LLO 4.1 Dismantle gear box LLO 4.2 Identify various components of Constant Mesh/Synchro Mesh Gear Box. LLO 4.3 Inspect components of gear box. LLO 4.4 Identify fault in gear box LLO 4.5 Assemble gear box.	4	Dismantling and Assembling Gear Box	2	CO2
LLO 5.1 Dismantle differential. LLO 5.2 Identify the components of Differential . LLO 5.3 Check components of diffrential. LLO 5.4 Identify Fault in differential. LLO 5.5 Assemble differential.	5	Dismantling and Assembling Differential unit.	2	CO2
LLO 6.1 Repair Drum and Disc Brake. LLO 6.2 Compare Drum and Disc Brake LLO 6.3 Carry out brake bleeding procedure.	6	* Repair Drum/Disc Brake.	2	CO3
LLO 7.1 Identify components of steering Systems. LLO 7.2 Draw steering linkages LLO 7.3 Identify possible causes of failure in steering system LLO 7.4 Suggest remedial action	7	Steering system	2	CO3
LLO 8.1 Identify components of Suspension systems LLO 8.2 Compare rigid axle and Independent suspension systems. LLO 8.3 Identify possible faults. LLO 8.4 Suggest remedial action	8	*Suspension system.	2	CO4
LLO 9.1 Perform battery test. LLO 9.2 Analyze the result of Open Voltage and Specific Gravity test for battery.	9	* Carry out battery test	2	CO5

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 10.1 Identify necessity of wheel balancing and wheel alignment. LLO 10.2 List stepwise procedure for wheel balancing and wheel alignment.	10	Wheel balancing and wheel alignment.	2	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) : NOT APPLICABLE

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Model of any TWO/FOUR wheel drive (2W/4W Drive) Vehicle.	1
2	Automobile Service tool kit with Axle Stand/Scissor/Hydraulic Screw Jack	2
3	Single plate Clutch components (Coil Spring and Diaphragm).	3
4	Working model of transmission system	3,4,5
5	Bike with Multiplate clutch and brakes	3,6
6	Constant Mesh / Synchro Mesh Gear Box used in four wheeler.	4
7	Working Models of Differential Assembly	5
8	Working Model of Disc Brake and Drum Brake	6
9	Working model of steering gear box Rack and Pinion , Recirculating Ball type and Power steering.	7
10	Model of Semi Elliptical Leaf Spring	8
11	Model of Mac-Pherson suspension.	8
12	12 Volt Lead Acid Battery in working condition ,7-50 AH.	9
13	Multi meter with voltage measuring range 0-100 V.DC ,	9
14	Hydrometer for specific gravity test (Sp.gr. Range of 1.100-1.300)	9

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

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to Automobile	CO1	8	4	4	8	16
2	II	Automobile Transmission system	CO2	10	4	6	10	20
3	III	Automobile Control Systems	CO3	8	2	4	8	14
4	IV	Automobile Suspension ,wheels and tyres	CO4	8	2	4	6	12
5	V	Introduction to Auto Electrical Systems	CO5	6	2	2	4	8
Grand Total				**40**	**14**	**20**	**36**	**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 25 marks for laboratory learning. End semester assessment of 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	-	2	2			
CO2	3	2	-	2	-	2	2			
CO3	3	2	-	2	-	2	2			
CO4	3	2	-	2	-	2	2			
CO5	3	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	Dr. Kirpal Singh	Automobile Engineering Vol. I and II	Standard Publications,7 December 2020 ISBN-13: 978-818 0142420.
2	C.P. Nakra	Basic Automobile Engineering	Dhanpat Rai Publishing Co. 1 January 2023 ISBN-13.978-9352168828
3	K.K.Jain, R.B.Asthana	Automobile Engineering	McGraw Hill 1JAN 2012 ISBN-13: 978-0070445291
4	Shrinivasan	Automotive Mechanics	McGraw Hill, 23 May-2018, ISBN-13 978-1760421502
5	Crouse W.H. and Anglin D.W.	Automotive Mechanics	McGraw-Hill (31 January 1993,ISBN-13 978-0028009438
6	Rajput R.K	A Text Book of Automobile Engineering	Laxmi Publications Pvt.ltd.,New Delhi, (2007) ISBN:97881170089919.
7	TOM Denton	Automobile Electrical and Electronics Systems	Routledge; 5th edition (12 September 2017) SBN-13 978-1138310490

Sr.No	Author	Title	Publisher with ISBN Number
8	Kamaraju Ramakrishna	Automobile Engineering	PHI Learning Pvt. Ltd., New Delhi, (20 ISBN: 9788120346109.
9	Prof. Dr. Ravi Prakash Arya	Engineering and Technology in Ancient India	INDIAN FOUNDATION FOR VEDIC SCIENCE ,ISBN: 9788194759300 (2020)

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	http://nptel.ac.in/courses. (NPTEL)	Automobile Courses
2	https://www.araiindia.com/Draft AIS Standards.asp.	Certification and Testing Agency (ARAI, Pune)
3	https://www.saeindia.org/.	For Membership of students in (SAE India)
4	https://www.youtube.com/watch?v=wCu9W9xNwtI.	Working of Manual transmission
5	https://www.youtube.com/watch?v=vOo3TLgL0kM.	Working of Synchromesh Gear Box
6	https://www.youtube.com/watch?v=aNGA5Ejq8A4.	Differential working Principle
7	https://www.youtube.com/watch?v=VFu-6tckyc8.	Axle Repair and Maintenance
8	https://www.youtube.com/watch?v=LCMs-7K8nLk.	Alloy wheels manufacturing
9	https://www.youtube.com/watch?v=W1vOzcBbgfg	Working of constant mesh gear box
10	https://www.youtube.com/watch?v=uTeMz6d7hwA	Operation of Synchromesh gear box
11	https://www.youtube.com/watch?v=M5H7UY55rrw	Battery open voltage test
12	https://www.youtube.com/watch?v=devo3kdSPQY&t=3s	Transmission system components.
13	https://www.youtube.com/watch?v=X6JejXjGQiQ	Mac-Pherson strut suspension
14	https://www.youtube.com/watch?v=rbYRif0Iy0w	Vehicle layout

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 Scie & 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 themselv with a large gathering. Seminar presentation boosts the confidence of the students and prepares them precisely for facing the audienc interviews and group discussions. The course on seminar is to enhance student's ability in the art of academic writing and to present it. also helps broaden the minds of the participants. Through this course on Seminar, students will develop new ideas and perspectives of t subject /themes of emerging technologies and services of their area of studies. Project initiation enhances project planning skill whi 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		Tota Mark
															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 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 t 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 programm 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 relev to the curriculum of the programme.
- **Seminar Preparation, and presentation**: The seminar shall be present with suitable software tools and supporting handout/notes. T 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 th 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 crite

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**
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 a .)
- 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/ Resou 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 shoul include the following folders and contents:

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

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

X. Sample Formats

1) Cover Page - Annexure-I

2) Index - Annexure-II

3) Assessment - Annexure-III

Annexure - I

MSBTE LOGO

SEMINAR Report

Institute Logo

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

as a partial fulfilment of requirement of the

THIRD YEAR DIPLOMA IN

Submitted by

Name of Student **Enrollment Number**

FOR THE ACADEMIC YEAR 20___20___

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

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

Annexure - II

Institute Name

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

Table of Contents

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***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)	Sc to (

SummativeAssessment

CRITERIA AND WEIGHTAGE

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

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

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

I. RATIONALE

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

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

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

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

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

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				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	
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

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

Name of mentor:
Signature of Mentor

XV FORMATS

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

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

4) Type:

   Govt / PSU / Pvt /

   Large scale / Medium scale / Small scale …..

5) Products/services offered by industry:

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

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

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

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

Signature of responsible person at Industry:

Format-2: Obtaining Consent Letter from parents/guardians

(Undertaking from Parents)

To,

The Principal,
_____,

Subject: Consent for Industrial Training.
Sir/Madam,

I am fully aware that -

i) My ward studying in _____ semester at your _____ institute has to undergo 12 weeks of Industrial training for partial fulfillment towards completion of Diploma in _____ Engineering.

ii) For this fulfillment he/she has been deputed at_____ industry, located at _____ for Industrial training /internship for the period from _____ to _____ .

With respect to above I give my full consent for my ward to travel to and from the mentioned industry. Further I undertake that –

a) My ward will undergo the training at his/her own cost and risk during training and/or stay.
b) My ward will be entirely under the discipline of the organization where he/she will be placed and will abide by the rules and regulations in face of the said organization.
c) My ward is NOT entitled to any leave during the training period.
d) My ward will regularly submit a prescribed weekly diary, duly filled and countersigned by the training supervisor of the organization to the mentor faculty of the polytechnic.

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

Signature :
Name : _____
Address : _____

Phone Number :

Format-3: Students Enrollment for Industrial Training

(Academic Year –)

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

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

To,

The HR Manager,

_____

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

Reference: Your consent letter no: ….

Sir,

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

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

Diploma programme in _____ Engg.

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

Diploma programme in _____ Engg.

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

Kindly extend all possible cooperation to the students for above.

Thanking you

Yours sincerely,

(Principal)
Name of the Institute:
with Seal

Cc- To HoD/Mentor

Format-5: Undertaking by the students

TO

Principal

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

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

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

Place :Signature of the student

Date :Reg. No.

Format-6: Internships Daily Diary

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

Enrollment Number: _____ Semester: _____ Academic Year _____

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

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

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.
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 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.	**Unit - III Industrial Design** 3.1 Importance of industrial design, Industrial 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 Using Chalk-Board 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

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.
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 LLO 2.3 Draw diagram of modified / developed bench using ergonomic principle.	2	*Development of existing Classroom bench/Chair/Drawing table/Laboratory table using relavant ergonomics principles.	4	CO2
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

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

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
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 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

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

Sr.No	Link / Portal	Description
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 :

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

HEATING VENTILATION AIR CONDITIONING **Course Code : 315373**

Programme Name/s : **Mechanical Engineering**
Programme Code : **ME**
Semester : **Fifth**
Course Title : **HEATING VENTILATION AIR CONDITIONING**
Course Code : **315373**

I. RATIONALE

Diploma Engineers must know the HVAC (Heating Ventilation Air Conditioning) systems due to the popularity and expansion of HVAC used in residential, commercial and industrial settings as well as the challenges involved with it. They should be familiar with the techniques, tools and systems used in heating, ventilation and air conditioning to maintain and modify the current needs. HVAC systems are crucial for ensuring comfort, safety, sustainability and efficiency in both residential and commercial applications. Therefore, this course is designed to provide knowledge & skills related to HVAC.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Choose appropriate Heating, Ventilation and Air-Conditioning systems and its components based on the requirement / field applications economically.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Apply Psychrometric principles for HVAC applications.
- CO2 - Select appropriate components for given HVAC applications.
- CO3 - Select appropriate Air conditioning systems for given situation.
- CO4 - Calculate cooling load for the particular situation.
- CO5 - Develop proper Air distribution systems according to site requirement for the given situation.

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	
315373	HEATING VENTILATION AIR CONDITIONING	HVA	DSE	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150

Total IKS Hrs for Sem. : 2 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 Draw various psychrometric processes on psychrometric chart for given Air properties. TLO 1.2 Calculate air properties by using Psychrometry for given data. TLO 1.3 Explain the factors affecting the thermal comfort of human body. TLO 1.4 Explain the strategies for improving indoor air quality. TLO 1.5 Explain outdoor design conditions for occupants in given situation.	**Unit - I Applied Psychrometry** 1.1 Introduction to Air cooling, Concept of Heat Pump. 1.2 Psychrometric Chart: Psychrometric properties of air, Psychrometric processes using By-Pass factor(BPF), Apparatus Dew Point (ADP), Sensible Heat Factor (SHF) and adiabatic mixing of two air streams (Simple numericals on Psychrometry). 1.3 Thermal Comfort: Basic parameters, Thermodynamics of human body, Thermal comfort and Comfort charts, Factors affecting thermal comforts. 1.4 Indoor Air Quality (IAQ): Indoor air contaminants, Basic strategies to improve indoor air quality. 1.5 Outdoor Design Conditions: Outdoor air requirements for occupants, Use of outdoor weather data in design, Outdoor weather characteristics and their influence.	Lecture Using Chalk-Board Presentations Videos Collaborative learning

HEATING VENTILATION AIR CONDITIONING **Course Code : 315373**

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.
2	TLO 2.1 Classify compressor used in HVAC system. TLO 2.2 Explain the working of any two components of HVAC system. TLO 2.3 Explain the working of any two auxiliary devices used in HVAC system.	**Unit - II Cooling System Components** 2.1 Refrigeration Compressors: Classifications, Construction and working of Hermetically sealed air compressor, Open type compressor, Rotary compressor, Centrifugal compressor, Screw and Scroll compressor and their applications. 2.2 Condensers: Classifications, Working of Air and Water-cooled condensers, Evaporative condensers, comparisons and applications. 2.3 Evaporators: Classification, Working & Applications of- finned type, Bared tube, Plate type, Flooded, Shell and Tube type evaporators. 2.4 Expansion devices: Classification, Capillary tube, Automatic expansion valve, Thermostatic expansion valve, their selection, working and application.	Lecture Using Chalk-Board Presentations Videos Collaborative learning
3	TLO 3.1 Classify Air conditioning system. TLO 3.2 Explain working of any one Air conditioning system. TLO 3.3 Explain the working of Cassette air conditioning system. TLO 3.4 Explain the constructional features of Central air conditioning. TLO 3.5 Select relevant components for given Air conditioning system. TLO 3.6 Select the insulating materials for given Air conditioning system. TLO 3.7 Describe the air conditioning maintenance procedure.	**Unit - III Air Conditioning Systems** 3.1 Classification of Air conditioning System- Summer and Winter, Year around air conditioning, Unitary air conditioning construction, application & comparison. 3.2 Construction and working of Cassette air conditioning system. 3.3 Central air conditioning- types, Direct and Indirect central air conditioning construction, application. 3.4 Insulations- Purpose, types of insulation, materials and their properties. 3.5 Heating Coils- Types 3.6 Introduction to Automobile Air conditioning system. 3.7 Basic requirements for Installation, testing of HVAC Systems, selection of appropriate Air conditioning systems for given situation with justification.	Lecture Using Chalk-Board Presentations Videos Collaborative learning Hands on experience on different test rigs/ prototype
4	TLO 4.1 List the factors to be considered for cooling load calculations. TLO 4.2 Identify the sources of heat gain in Air Conditioning system for the given situation with justification. TLO 4.3 Calculate cooling load for the given situation.	**Unit - IV Cooling Load Calculations** 4.1 Introduction & necessity of Cooling Load Calculations- Energy Efficiency, System Sizing, Occupant Comfort. 4.2 Factors to be considered for cooling load calculations. 4.3 Calculation of Sensible and Latent heat gain sources. 4.4 Cooling load calculation for- Auditorium/ Computer laboratory/ Class room.	Lecture Using Chalk-Board Presentations Videos Collaborative learning Hands on experience

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.
5	TLO 5.1 Explain the principles of Ventilation including Natural and Mechanical ventilation systems. TLO 5.2 Describe different types of air distribution systems. TLO 5.3 List the design criteria for duct system. TLO 5.4 Select appropriate components for an air distribution system. TLO 5.5 Describe design criteria for Air distribution system in given situation.	**Unit - V Ventilation, Infiltration & Air Distribution Systems** 5.1 Ventilation and Infiltration: Natural ventilation, Mechanical ventilation, Concept of Basement Ventilation, Heat Sensors. 5.2 Concept of Air handling unit, Air distribution system- Closed perimeter system, Extended perimeter system, Radial duct system, construction and application of Supply, Return and Make up ducts. 5.3 Duct Design: Definition of duct and types of ducts, Economic factors influencing duct layout, Materials for ducts and its specification, Flow through duct, Pressure in ducts, losses in ducts, Equivalent diameter of a circular duct for rectangular sections, Factors considered for duct design. (Simple numericals on duct design). 5.4 Air Distribution System: : Factors to be considered for Air distribution system, Types of Air distribution devices. Types of Fans used in air conditioning applications, Types of Supply air outlets, Selection and location of Outlets, Filters, Diffusers, Grills, Blowers and Dampers. Air jet nozzles, Concept of Variable Air Volume (VAV) systems and working.	Chalk-Board Presentations Videos Collaborative learning Hands on experience

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 air properties using appropriate Psychrometer efficiently. LLO 1.2 Calculate various air properties using Psychrometeric Chart.	1	*Measurement of air properties.	2	CO1
LLO 2.1 Identify the components of a Unitary Air conditioner. LLO 2.2 Make use of manufacturer catalogue for specifications and ratings for each component.	2	*Identification of various components of Unitary Air conditioning system with specifications.	2	CO2
LLO 3.1 Select the proper tools for dismantling and assembling. LLO 3.2 Inspect condition of components.	3	Dismantling & assembling of the Cassette air conditioning system.	2	CO2 CO3
LLO 4.1 Identify the components of a Central Air Conditioning system. LLO 4.2 Demonstrate the Central Air Conditioning system.	4	Demonstration on Central Air conditioner system.	2	CO2 CO3
LLO 5.1 Select the proper tools for dismantling and assembling. LLO 5.2 Inspect condition of components.	5	Dismantling & assembling of Automobile Air conditioner.	2	CO2 CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 6.1 Conduct performance test on Air Conditioning Test rig to evaluate the cooling effect. LLO 6.2 Measure and record parameters such as supply air temperature, return air temperature, outdoor air temperature and humidity levels.	6	*Trial on Air conditioning system.	2	CO4
LLO 7.1 Analyze the specific thermal loads and environmental conditions of a specific space. LLO 7.2 Calculate heat gains and losses.	7	*Cooling and heating load calculations.	2	CO4
LLO 8.1 Prepare Air distribution system layout. LLO 8.2 Create schematic layouts by using Auto-CAD that illustrate the proposed duct routes, sizes, and connections.	8	*Prepare layout of Air distribution system of given space.	2	CO4 CO5
LLO 9.1 Identify the components of a railway HVAC system. LLO 9.2 Demonstrate the railway HVAC system.	9	Demonstration on railway HVAC system.	2	CO3 CO5
LLO 10.1 Identify the components of Air conditioning system used in ancient India. LLO 10.2 Prepare a report on Air conditioning system used in ancient India.	10	Air conditioning system used in ancient India. (IKS)	2	CO1 CO2 CO3 CO4 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	Measurement of air properties. Psychrometeric Chart with Digital Psychrometer/ Sling Psychrometer/Wall mounted Psychrometer/: Temperature measurement : range/accuracy/resolution: -4°to122°F (-20° to 50°C)/ ±1.8°F (±1°C)/0.1° Humidity measurement range/resolution: 0 to 100%RH/0.1% Humidity measurement accuracy: ±3% of reading from 10 to 90%RH; ±4% Dew point measurement range/accuracy: -47° to 122°F/±1.2°F (±0.6°C) Response time: 60 seconds (typical) Readout sizes: 3/8 in. high digits on upper readout; 3/16 in. high digits on lower readout Auto power off: 20 minutes of inactivity Weight: 2.65 oz. (75g) Power source: Two "AAA" batteries (included)	1

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
2	Identification of various components of Unitary Air conditioner with specifications. Cooling Capacity: Min 1 TR or more.	2
3	Dismantling & assembling of the Cassette air conditioning system. Cooling Capacity: Min 1 TR or more.	3
4	Demonstration on Central Air conditioner system. Cooling Capacity: Min 10 TR or more.	4
5	Dismantling & assembling of Automobile Air conditioner. Automobile AC Compressor, Capacity: 10 - 1000 CFM or more.	5
6	Experimental set up of Air conditioning system. Cooling Capacity: Min 1.5 TR or more.	6
7	Cooling and heating load calculations. Lux meter: MAX / MIN, Backlight, Auto Power Off. Range: 0 ~ 100,000 lux / 0 ~20,000 Accuracy: ± 5% rdg + 10 dgt (< 10.000 lux / fc) ± 10% rdg + 10 dgt (>10.000 lux/fc) Resolution: 0.1 lux or 0.1 fc. Anemometer: Temperature Range: -20.0~60.0ºC Humidity Range (Rh %): 0.0% ~ 99.9 % RH Range: 0.70~30.00 m/s	7
8	Prepare layout of Air distribution system of given space. Educational version license of Auto-CAD or as per availability.	8
9	Demonstration on railway HVAC system. By using available Interactive Classroom Techniques.	9

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

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Applied Psychrometry	CO1	6	2	4	4	10
2	II	Cooling System Components	CO2	8	2	4	8	14
3	III	Air Conditioning Systems	CO3	10	2	8	6	16
4	IV	Cooling Load Calculations	CO4	6	2	4	6	12
5	V	Ventilation, Infiltration & Air Distribution Systems	CO5	10	2	4	12	18
Grand Total				**40**	**10**	**24**	**36**	**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 25 marks for laboratory learning.

End semester assessment of 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	2	3	2			
CO2	3	2	-	2	-	3	2			
CO3	3	2	-	2	-	3	2			
CO4	3	3	-	2	3	3	2			
CO5	3	2	3	3	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	Khurmi R.S.& J.K.Gupta	Refrigeration and Air Conditioning	S. Chand publication, New Delhi,(2008), ISBN-10:8121927811
2	Arora C.P.	Refrigeration and Air Conditioning	Tata McGraw-Hill Publication, New Delhi, (2009), ISBN-13-978-07-008390-5
3	Ananthnarayan P.M	Basic Refrigeration and Air Conditioning	Tata McGraw-Hill Publication, New Delhi, (2013), ISBN- 9781259062704
4	Sapali S. N.	Refrigeration and Air Conditioning	PHI publication, New Delhi, (2013) ISBN - 9788120348721
5	Prasad Manohar	Refrigeration and Air Conditioning	New Age International, New Delhi, (2011), ISBN-9788122414295
6	R.K.Rajput	Refrigeration and Air Conditioning	S.K.Kataria & Sons, New Delhi, (2018) ISBN- 13-9788188458400
7	Dossat R.J.	Principles of Refrigeration	John Wiley and Sons Ltd, UK, (2009) ISBN 978-0130272706

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://youtu.be/YoN5251ta18?si=7t18E4M3uUVgJ_r4	Basic Concepts of Psychrometry and Air-Conditioning
2	https://youtu.be/WM09L5aUuyE?si=rX8vNmF3nxCDOTM-	Fundamentals of Thermal Comfort
3	https://youtu.be/NpaR7x-caAo?si=1Sg1Uz0kRwpua_9r	Indoor Air Quality
4	https://youtu.be/yqpR7udHBEA?si=CXsKDKAWaHemwGOA	Outdoor Design Conditions

HEATING VENTILATION AIR CONDITIONING **Course Code : 315373**

Sr.No	Link / Portal	Description
5	https://youtu.be/YUgN5D-bmpg?si=x6nxT3cwdxwze2mc	Air-Conditioning Systems
6	https://youtu.be/tNj8ocNO4iw?si=_cvQGVSwOOo1jXH6	working of Cassette air conditioning system
7	https://youtu.be/xMkgzVR1Luo?si=uyDAtROjjxnMg7MT	Introduction to HVAC
8	https://youtu.be/rTBoP8LbTJA?si=2DCzHNZ3E3rJbEhU	Cooling Load Calculation
9	https://youtu.be/gRcgUfeAHl4?si=5l0EdmQDsYXGy2Q_	Air Distribution System-1
10	https://youtu.be/7Kd3p-xDT2U?si=Ek-Z2yyg9g24I7NE	Air Distribution System-2
11	https://youtu.be/BNl638zbWRQ?si=4Mes8896maK3_n3Z	Variable Air Volume (VAV) systems and working.

Note :

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

POWER PLANT ENGINEERING **Course Code : 315374**

Programme Name/s : Mechanical Engineering
Programme Code : ME
Semester : Fifth
Course Title : POWER PLANT ENGINEERING
Course Code : 315374

I. RATIONALE

The economic growth of a nation essentially results in growth in the power sector and electric power is the main resource. Various power plants are playing a vital role in the generation of electricity. Most of the power plants are using mechanical engineering equipment and components. Hence, this course will provide the basic knowledge of the components, operation, and maintenance of power plants to the students and also acquaint them with the latest technological advances taking place in the sector. Therefore, this course is designed to cater the requirements of energy efficient devices of power plant.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry/employer expected outcome through various teaching learning experiences: "Apply knowledge & skills related to power plant engineering to carryout assigned task(s) in conventional power plants and other 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 - Choose appropriate fuel for power plant in given situation.
- CO2 - Apply relevant knowledge & skills to maintain modern steam power plant efficiently and safely.
- CO3 - Use knowledge and skills related to Gas Power Plant and Waste Heat Recovery properly in given situation.
- CO4 - Use suitable strategies to run nuclear power plants safely.
- CO5 - Calculate economic parameters of various power plants.

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	
315374	POWER PLANT ENGINEERING	PPE	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 Compare different power plants in India and world TLO 1.2 List various power corporations in India. TLO 1.3 List the different criteria for site selection. TLO 1.4 State the IBR Norms for steam power plant. TLO 1.5 State the regulation for pollution control in power plants. TLO 1.6 State the importance of power plant. TLO 1.7 Classify the power plants on the basis of given criteria. TLO 1.8 Classify the fuel used in given power plant.	**Unit - I Fundamental of Power plant** 1.1 Present Indian & Global scenario of demand and supply of conventional power plant with respect to available resources. 1.2 Over view of Power generating plants- Govt. and Private corporations in India with including power generating capacity. 1.3 Site selection criteria for steam power plant. 1.4 IBR (Indian Boiler Regulation) Norms for steam power plant. 1.5 CPCB (Central Pollution Control Board) and MPCB (Maharashtra Pollution Control Board) Norms for Power Plants. 1.6 Introduction to power plants: their importance and classification. 1.7 Types of fuels used in conventional power plant and their properties (Calorific value, Flash point & Fire point) & Relative Cost per kWh (Power Plant Production Cost on the basis of fuel used).	Chalk-Board Presentations Model Demonstration 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.
2	TLO 2.1 Sketch the layout of modern steam power plant. TLO 2.2 Explain working of different components of steam power plant. TLO 2.3 State the functions of different components of steam power plant. TLO 2.4 Sketch the constructional details of different components of steam power plant. TLO 2.5 Illustrate the fuel handling equipments. TLO 2.6 Explain the construction and working of different components of ash handling system. TLO 2.7 Write the various applications of fly ash. TLO 2.8 State the objectives of feed water treatment. TLO 2.9 Describe with sketches working of the given FBC boilers. TLO 2.10 Explain the construction and working of various temperatures & feed water control system.	**Unit - II Modern Steam Power Plant** 2.1 Schematic diagram of modern steam power plant. 2.2 Construction, working and functions of super heater, air preheater, economizer, feed pump, electrostatic precipitator, steam traps and its types. 2.3 Fuel handling system- Coal handling layout, Pulverization of coal – Ball Mill 2.4 Ash Handling System- Types of ash (Bottom Ash & Fly Ash) , Layout, Components used & their functions. Commercial use of fly ash. 2.5 Feed Water Treatment- Objective of feed water treatment, Parameters of feed water. (Total Hardness, pH, Total Dissolved Solid (TDS)) 2.6 Fluidized Bed Combustion Boiler (FBC): Types, Construction and Working, Advantages and Disadvantages. 2.7 Concept of steam temperature control and boiler feed water control (Three Element Control only).	Chalk-Board Presentations Model Demonstration Video Demonstrations
3	TLO 3.1 Draw layout of gas power plant. TLO 3.2 List components of gas power cycle. TLO 3.3 Compare different methods for improving efficiency of gas turbine power plant. TLO 3.4 Explain the need of waste heat recovery system. TLO 3.5 Describe with sketches working principle of cogeneration. TLO 3.6 Describe Trigeneration in the given power plants.	**Unit - III Gas Power Plant and Waste Heat Recovery** 3.1 Introduction to Gas Turbine Power Plant, Concept of Brayton cycle. (No Numerical) 3.2 Arrangement of open and close cycle with constant pressure gas turbine power plant. 3.3 Components of gas turbine power plant and its function. 3.4 Methods to improve the thermal efficiency of a simple open cycle constant pressure gas turbine power plant (No derivation). Advantage & Disadvantages over other power plant.(No Numerical) 3.5 Waste heat recovery in thermal power plants, its need, opportunities, present practices. 3.6 Cogeneration, its need, opportunities, Application of cogeneration in sugar industry, Introduction to bagasse fired boiler. 3.7 Trigeneration, its need, opportunities, presents practices.	Chalk-Board Presentations Model Demonstration 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.
4	TLO 4.1 Sketch the layout of nuclear power plant. TLO 4.2 Explain various nuclear reactor used in nuclear power plant. TLO 4.3 Choose the waste disposal methods. TLO 4.4 Explain the present scenario of nuclear power plant in India. TLO 4.5 State the regulation for nuclear power plant.	**Unit - IV Nuclear Power Plant** 4.1 Introduction to nuclear power plant - Site selection Criteria - Nuclear fuel - Layout 4.2 Nuclear reactor - Construction and Working of - Pressurized Water Reactor (PWR) - Boiling Water Reactor (BWR) 4.3 Nuclear Waste and Disposal. 4.4 Present Nuclear power scenario in India 4.5 Introductions to regulating agencies and regulations, Atomic Energy Regulatory Board (AERB), International Atomic Energy Agency (IAEA), it's a regulation method.	Chalk-Board Presentations Model Demonstration Video Demonstrations
5	TLO 5.1 Explain captive power plant. TLO 5.2 State the National Mission for Enhanced Energy Efficiency (NMEEE) in power plant. TLO 5.3 Estimate the cost of electricity in the given situation using simple numerical problems. TLO 5.4 Calculate performance parameters for the given power plant using simple numerical problems.	**Unit - V Recent Trends And Economic Analysis of Power Plants** 5.1 Introduction to captive power plant, Definition, Benefits. 5.2 National Mission for Enhanced Energy Efficiency (NMEEE) in power plants- Perform, Achieve and Trade (PAT), Market Transformation for Energy Efficiency (MTEE), Market Transformation for Energy Efficiency (MTEE), Framework for Energy Efficient Economic Development (FEEED). 5.3 Estimation of the production cost of electrical energy. (Simple numerical) 5.4 Estimation of various performance parameters. (Simple numerical)	Chalk-Board Presentations Model Demonstration 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 Select appropriate fuel for given conventional power plant based on properties of fuel. LLO 1.2 Compare any two fuels used in conventional power plants on basis of three parameters.	1	*Conventional Power Plant: Fuels and their properties.	2	CO1
LLO 2.1 Use Digital pH meter and TDS meter. LLO 2.2 Measure the parameters of feed water by using Digital pH meter and TDS meter.	2	*Find the feed water parameters.	2	CO2
LLO 3.1 Dismantle Float and thermodynamic steam trap. LLO 3.2 Check the status of components in the float and thermodynamic steam trap. LLO 3.3 Assemble float and thermodynamic steam trap.	3	Assembling and dismantling of Float and thermodynamic steam trap.	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 4.1 Demonstrate the ash handling system using suitable media. LLO 4.2 Prepare a layout comprising various components of the of the ash handling system.	4	Ash handling system or electrostatic precipitator (ESP).	2	CO2
LLO 5.1 List the components of gas turbine power plant. LLO 5.2 Prepare the model of gas turbine power plant using waste material in the institute.	5	Layout model of gas turbine power plant.	2	CO3
LLO 6.1 Identify the components of thermal power plant. LLO 6.2 Demonstrate the working of cogeneration in thermal power plant using media.	6	*Cogeneration in the given thermal power plant	2	CO3
LLO 7.1 Identify the components of nuclear power plant. LLO 7.2 Demonstrate the construction and working of nuclear power plant using available animation. LLO 7.3 Draw layout of nuclear power plant.	7	*Working of nuclear power plant.	2	CO4
LLO 8.1 Choose the waste disposal method for nuclear waste. LLO 8.2 Prepare the model of waste disposal process for nuclear waste using waste material in the institute.	8	Waste disposal model for nuclear waste.	2	CO4
LLO 9.1 Demonstrate the working of captive power plant using media. LLO 9.2 Identify the components of nuclear power plant. LLO 9.3 Draw layout of nuclear power plant.	9	Captive steam power plant with all technical specifications.	2	CO5
LLO 10.1 Calculate the connected electricity load of any one lab. LLO 10.2 Suggest the type of power plant required on the basis of load and justify your answer.	10	*Connected electricity load of any one laboratory.	2	CO5
LLO 11.1 Use EES software or equivalent. LLO 11.2 Select the working parameters of a given power plant LLO 11.3 Determine the efficiency of steam power plant considering any two parameters using EES software.	11	Modern steam power plant efficiency.	2	CO2 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	EES freeware (https://fchart.com/ees/demo.php)	11
2	Digital pH meter : pH Range-0-14pH, pH Resolution- 0.01pH, pH Accuracy-+0.002pH,	2
3	TDS meter: TDS Measuring Range: 0-9990 PPM, Resolution: 1 PPM (10 PPM for1000 to 99990 PPM), Accuracy: ±2%, Temperature Measuring Range: 0° to 50°C	2
4	Single Orifice Float Trap: size 25mm	3
5	Thermodynamic steam strap: Size 15mm	3

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	Fundamental of Power plant	CO1	6	4	4	4	12
2	II	Modern Steam Power Plant	CO2	12	4	8	6	18
3	III	Gas Power Plant and Waste Heat Recovery	CO3	10	4	4	6	14
4	IV	Nuclear Power Plant	CO4	6	4	4	4	12
5	V	Recent Trends And Economic Analysis of Power Plants	CO5	6	2	4	8	14
Grand Total				**40**	**18**	**24**	**28**	**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 25 marks for laboratory learning.
- • End semester assessment of 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	3	3			
CO2	3	-	-	3	3	3	3			
CO3	3	-	-	3	3	3	3			
CO4	3	-	-	3	3	3	3			
CO5	3	3	3	3	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	R.K. Rajput	A Text Book of Power Plant Engineering.	Laxmi Publications, New Delhi 2016,ISBN-13 978-8131802557
2	Arora and Domkundwar	Power Plant Engineering	Dhanpat Rai & CO (P) LTD 2022, ISBN-13 978-8177001952
3	P. K. Nag	Power Plant Engineering	McGraw Hill 2017, ISBN-13 978-9339204044
4	G. R. Nagpal	Power Plant Engineering	Khanna publishers 2002, ISBN-13 978-8174091550
5	Dr. P. C. Sharma	Power Plant Engineering.	S. K. Kataria 2013, ISBN-13 978-9350143841
6	M.M. EL-Wakil	Power Plant Technology	McGraw Hill 2084 ISBN-13 978-0070192881
7	Bernhardt G A Sarotzki, William A Vopat	Power Station Engineering and Economy	Tata Mc Graw Hill 2001, ISBN-13 978-0070995734
8	P.K.Das & A.K.Das	An Introduction to Thermal Power Plant Engineering and Operation : For Power Plant Professionals	Notion Press; 1st edition 2018, ISBN-13 978-1643248622
9	A K Raja, Amit Prakash Srivastava and Manish Dwivedi	Power Plant Engineering	New age international Publishers 2020, ISBN-13 978-9380386782
10	Gupta Manoj Kumar	Power Plant Engineering	PHI Learning Publication 2012, ISBN-13 978-8120346123

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://static.investindia.gov.in/s3fs-public/2023-04/Energy StatisticsIndia2023.pdf	Present Indian Energy scenario
2	https://beeindia.gov.in/en/nmeee-0	Bureau of Energgy Efficiency (BEE)
3	http://www.indiaenvironmentportal.org.in/files/NMEEE.pdf	Recent Trends
4	https://www.youtube.com/watch?v=IdPTuwKEfmA	Thermal Power Plant
5	https://www.youtube.com/watch?v=zcWkEKNvqCA	Gas Power Plant
6	https://www.youtube.com/watch?v=vggzl9OngaM	Nuclear Power Plant
7	https://www.youtube.com/watch?v=NgCb4Er9mew	Nuclear Power Plant
8	https://www.youtube.com/watch?v=ell3ExEpzd8	Waste Heat Recovery

POWER PLANT ENGINEERING **Course Code : 315374**

Sr.No	Link / Portal	Description
9	https://www.youtube.com/watch?v=1kMT7BJ0d-8	Cogeneration Power Plant
10	https://www.youtube.com/watch?v=w4MnNfUsBPU	Thermodynamics Steam Trap
11	https://www.youtube.com/watch?v=5ZjQhh-7Dkc	Thermodynamics Steam Trap
12	https://www.youtube.com/watch?v=FV9pmX86j8o	Float Steam Trap
13	https://www.youtube.com/watch?v=AcyFY3iAdlw	Electrostatic Precipitator
14	https://www.youtube.com/watch?v=is5wdVgPOkI	Feed Water Treatment

Note :

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