|| Jai Sri Gurudev ||

Sri Adichunchanagiri Shikshana Trust®

SJB Institute of Technology

An Autonomous Institution under VTU

No.67, BGS Health & Education City, Dr.Vishnuvardhan Rd, Kengeri, Bengaluru, Karnataka 560060

MECHANICAL ENGINEERING

Autonomous

SCHEME & SYLLABUS BOOKLET

2023 - SCHEME- [UG]

5TH & 6TH SEMESTER

2023-SCHEME

5TH & 6TH SEMESTER

SCHEME & SYLLABUS

|| Jai Sri Gurudev ||
Sri Adichunchanagiri Shikshana Trust (R)
SJB Institute of Technology
BGS Health and Education City, Dr. Vishnuvardhana Road, Kengeri, Bengaluru-560060
Approved by AICTE, New Delhi.
Autonomous Institution affiliated to Visvesvaraya Technological University, Belagavi
Recognized by UGC, New Delhi with 2(f) & 12 (B), Accredited by NAAC with 'A+'grade,
Certified by ISO 9001 - 2015

Autonomous Scheme of Teaching & Examinations (ST&E) (Tentative) UG - BE 3rd Year ME

SCHEME: 2023 SEM: V Revision date: 05-04-2025

S. #	Course Type	Course type Series	Course Code	Course Title	Teaching Dept.	QP setting dept	Credits	Teaching Hrs/Week				Examinations				
								L	T	P	O	CIE Marks	SEE (Dur. & Marks)			
								Lecture	Tutorial	Practical	PBL/ABL / SL/etc.		Dur.	Th.	Lab	Tot.
1	PCC	3	23MET501	Theory of Machines	ME	ME	**3**	3	0	0		50	03	50	-	100
2	IPCC	5	23MEI502	Turbo Machines	ME	ME	**4**	3	0	2		50	03	50	-	100
3	IPCC	6	23MEI503	Automation in Manufacturing	ME	ME	**4**	3	0	2		50	03	50	-	100
4	PCCL	3	23MEL504	3D Printing - CNC programing Lab	ME	ME	**1**	0	0	2		50	03	-	50	100
5	PEC	1	23MEP51y	Professional Elective Course - 1	ME	ME	**3**	3	0	0		50	03	50	-	100
6	ETC	3	23MEE53y	Emerging Technology Course - 3	ME	ME	**3**	3	0	0	@	50	03	50	-	100
								or								
								2	0	2						
7	HSMC	6	23SFHH06/ 23UHVH07	Bioscience or UHV-Universal Human Values	any dept	any dept	**1**	0	2	0	@	50	02	50	-	100
8	AEC	5	23MEAE5y	Ability Enhancement Course - 5	ME	ME	**1**	0	2	0		50	02	50		100
								(or)								
								0	0	2					50	
9	NCMC	4	23PASN01	Physical Education - Sports and Athletics	PED	PED	**PP/NP**	-	-	-	2	50	-	-	-	50
			23YOGN02	Yoga	PED	PED										
			23NSSN03	NSS - National Service Scheme	NSS	NSS										
			23NCCN04	NCC - National Cadet Corps	NCC	NCC										
			23IKSN05	Indian Knowledge System	HSS	HSS										
Total							**20**	**17**	**4**	**10**	**2**	**450**		**350**	**100**	**850**

PCC: Professional Course; IPCC: Integrated Professional Core Course; PCCL: Professional Core Course Laboratory; AEC: Ability Enhancement Course; HSMC: Humanities, Social Sciences & Management Course; NCMC: Non Credit Mandatory Course;
{@ - Compulsory one activity during the semester};
{I.E.-Industry Experts}.
PBL: project Based learning; ABL: Activity Based Learning; SL: Self-Learning

ETC (Emerging Technology Course):
For ETC (L:T:P:O) can be plaanned by the depts considering practicality & possibility of conduction, same shall be indicated along with course title in the list, if altered than above. If planned altering the prescription, the same shall be approved at the department BOS & authorities. Atleast one activity is mandatory during the delivery of the course. The guidelines is applicable to all the semesters III to VI semesters (ETC-1 to ETC-4).

Bioscience & UHV-Universal Human Values:
1) Any one of the course will be offered by the departments in each semester of IV & V based on the institutional planning.
2) Both the courses shall be studied and completed by the students registering each in the two semesters. For example, if Bioscience is offered in the IV semester, UHV-Universal Human Values is offered in the V semester.

Ability Enhancement Course-5: 23xxAE5y - 1 Credit course
1) The courses and the syllabus shall be defined by the respective dept. BOS.
2) SEE will be MCQ if offered as theory course. If offered as LAB course, SEE will be practical, with two internal examiners. Handled by Controller of Examinations.

NCMC (Non Credit Mandatory Course) for course type series-4: Refer to guidelines in III SEM.

Professional Elective Course - 1		**Emerging Technology Course - 3**		**Ability Enhancement Course - 5**	
Course Code	**Course Title**	**Course Code**	**Course Title**	**Course Code**	**Course Title**
23MEP511	Non Traditional Machining	23MEE531	Introduction to Artificial Intelligence	23MEAE51	Industrial Internet of Things (IIoT)
23MEP512	Mechatronics	23MEE532	Robotics and Automation	23MEAE52	Introduction to data Analytics
23MEP513	Supply Chain Management and Introduction to SAP	23MEE533	Electric and Hybrid Vehicle Technolgy	23MEAE53	Finance for Engineers
23MEP514	Energy Intelligence	23MEE534	Optimization Techniques	23MEAE54	Marketing Management

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Autonomous Scheme of Teaching & Examinations (ST&E) (Tentative) UG - BE 3rd Year ME

SCHEME: 2023 **SEM: VI** **Revision date: 05-04-2025**

S. #	Course Type	Course type Series	Course Code	Course Title	Teaching Dept.	QP setting dept	Credits	Teaching Hrs/Week				Examinations				
								L	T	P	O	CIE Marks	SEE (Dur. & Marks)			
								Lecture	Tutorial	Practical	PBL/ABL / SL/etc.		Dur.	Th.	Lab	Tot.
1	PCC	4	23MET601	Machine Design	ME	ME	3	3	0	0		50	03	50	-	100
2	IPCC	7	23MEI602	Heat Transfer	ME	ME	4	3	0	2		50	03	50	-	100
3	PCCL	4	23MEL603	Design Laboratory	ME	ME	1	0	0	2		50	03	-	50	100
4	PEC	2	23MEP62y	Professional Elective Course - 2	ME	ME	3	3	0	0		50	03	50	-	100
5	OEC	1	23MEO61y	Open Elective Course - 1	ME	ME	3	3	0	0		50	03	50	-	100
6	ETC	4	23MEE64y	Emerging Technology Course - 4	ME	ME	3	3	0	0	@	50	03	50	-	100
							3	2	0	2						
7	AEC	6	23RMAE61	Research Methodology & IPR	Any dept	Any dept	3	3	0	0	@	50	03	50	-	100
8	PRJ	1	23MEPRJ1	Major Project - Phase I	ME	ME	2	0	0	4	@	50	03	-	50	100
9	HSMC	7	23SCRH08	Social Connect & Responsibility	Any dept	Any dept	1	1	0	0	@	50	-	-	-	50
10	NCMC	4	23PASN01	Physical Education - Sports and Athletics	PED	PED	PP/NP	-	-	-	2	50	-	-	-	50
			23YOGN02	Yoga	PED	PED										
			23NSSN03	NSS - National Service Scheme	NSS	NSS										
			23NCCN04	NCC - National Cadet Corps	NCC	NCC										
			23IKSN05	Indian Knowledge System	HSS	HSS										
Total							**26**	**21**	**0**	**10**	**2**	**500**		**300**	**100**	**900**

PCC: Professional Course; IPCC: Integrated Professional Core Course; PCCL: Professional Core Course Laboratory; PEC: Professional Elective Course; OEC: Open Elective Course;
HSMC: Humanities, Social Sciences & Management Course; AEC: Ability Enhancement Course; NCMC: Non Credit Mandatory Course; PRJ: Project work.
{@ - Compulsory one activity during the semester}; {I.E.-Industry Experts}; PBL: project Based learning; ABL: Activity Based Learning; SL: Self-Learning
NOTE: CIE & SEE guidelines for S. #7: AEC-23RMAE61-Reserach Methodology & IPR will be same as 3 credit courses BSC/ESC/PCC/ETC/PEC/OEC as mentioned in serial no. 1 of CIE & SEE guidelines.

Open Elective Courses (OEC):

1) Open Electives listed here are to offer for other department students.
2) Students shall select open elective courses offered from other departments, separate consolidated list of courses offered from various departments will be published time to time.

ETC (Emerging Technology Course):

For ETC (L:T:P:O) can be plaanned by the depts considering practicality & possibility of conduction, same shall be indicated along with course title in the list, if altered than above. If planned altering the prescription, the same shall be approved at the department BOS & authorities. Atleast one activity is mandatory during the delivery of the course. The guidelines is applicable to all the semesters III to VI semesters (ETC-1 to ETC-4).

NCMC (Non Credit Mandatory Course) for course type series-4: Refer to guidelines in III SEM.

Professional Elective Course - 2 (23xxP62y)		**Open Elective Course - 1 (23xxO61y)**		**Emerging Technology Course - 4 (23xxE64y)**	
Course Code	**Course Title**	**Course Code**	**Course Title**	**Course Code**	**Course Title**
23MEP621	Total Quality Management	23MEO611	Project Management	23MEE641	Data Analytics with R
23MEP622	Mechanical Vibration and Condition Monitoring	23MEO612	Product Design and Development	23MEE642	Advanced Production Systems
23MEP623	Operation Research	23MEO613	Energy Intelligence	23MEE643	Product Design and Development
23MEP624	Design for Manufacturing and Assembly	23MEO614	Electric and Hybrid Vehicle Technolgy	23MEE644	Automobile Engineering

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MECHANICAL ENGINEERING
5th Semester Syllabus

Semester:	V	**Course Type:**	PCC		
Course Title:	**THEORY OF MACHINES**				
Course Code:	23MET501			**Credits:**	03
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

- To understand the concept of machines, mechanisms and to Analyze a mechanism for displacement, velocity and acceleration at any point in a moving link.
- To understand the force motion relationship in components subjected to external forces and analysis of standard mechanisms
- To understand the theory of gears and gear trains.
- To understand the undesirable effects of unbalances resulting from prescribed motions in mechanism.
- To understand the principles in mechanisms used for speed control and stability of a governor and effect of gyroscopic couple on plane disk and aircraft.

II. Teaching-Learning Process (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.
Course objectives:
1. These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.
2. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
3. Chalk and Talk method for Problem Solving.
4. Adopt flipped classroom teaching method.
5. Adopt collaborative (Group Learning) learning in the class.
6. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.

III. COURSE CONTENT

III(a). Theory PART	
Module-1:	8Hrs
Introduction: Mechanisms and machines, Kinematic pairs-types, degree of freedom, Kinematic chains and their classification, Kinematic inversions, **Velocity and Acceleration analysis of planar mechanisms Graphical method:** Velocity and Acceleration Analysis of Mechanisms Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Mechanism illustrating Corioli's component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing. **Text book 1**: Chapter 1, 2,3	
RBT Levels:L1,L2, L3	
Module-2:	8Hrs
Static force analysis: Static equilibrium, analysis of four bar mechanism, slider crank mechanism. **Dynamic force analysis:** D'Alembert's principle, analysis of four bar and slider crank mechanism**.** **Flywheel:** Introduction to Flywheel and calculation of its size for simple machines like punching machine, shearing machine **Text book 1**: Chapter 11	
RBT Levels: L1,L2, L3	
Module-3:	8Hrs
Spur Gears: Gear terminology, law of gearing, path of contact, arc of contact, contact ratio of spur gear. Interference in involute gears, methods of avoiding interference, condition and expressions for minimum number of teeth to avoid interference. **Gear Trains:** Simple gear trains, compound gear trains. Epicyclic gear trains: Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains, torque calculation in epicyclic gear trains. Discussions on applications of gear trains. **Text book 1: Chapter 14,15**	
RBT Levels: L1,L2,L3	
Module-4:	8Hrs
Balancing of Rotating Masses: Static and Dynamic Balancing, Balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes. Discussions on applications. Introduction to reciprocating masses (No Numerical Problems) **Governors:** Types of Governors; Force Analysis of Porter and Hartnell Governors. Controlling Force, Stability, Sensitiveness, Isochronism, Effort and Power. Discussion on applications. **Text book 1: Chapter 9, 12**	
RBT Levels: L1,L2,L3	
Module-5:	8Hrs

Gyroscope:
Vectorial Representation of Angular Motion, Gyroscopic Couple. Effect of Gyroscopic Couple on Ship, Plane Disc, Aircraft, Stability of Two Wheelers and four wheelers.
Text Book 1: Chapter 13

RBT Levels: L1,L2,L3

Course Outcome

At the end of the course the student will be able to :
1. Apply the Knowledge of mechanisms and their motion and the inversions of mechanisms.
2. Analyse the velocity, acceleration of links and joints of mechanisms.
3. Solve problems on mechanisms for static and dynamic equilibrium.
4. Carry out the balancing of rotating masses.
5. Investigate the different types of governors used in real life situation and effect of gyroscopic couple on plane disk, Aircraft, stability of two wheelers and ship.

IV. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	2												1			
CO2	2												2			
CO3		3											2			
CO4		3											3			
CO5		3	3		2								2			

V. Assessment Details (CIE & SEE)

General Rules Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section – 1

Semester End Examination (SEE): Refer Annexure section – 1

VI. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1.	Theory of Machines Kinematics and Dynamics	Sadhu Singh	2019	3nd Edition, Pearson
2.	Mechanism and Machine Theory	G. Ambekar	2009	PHI 2009
Reference Books				
1.	Theory of Machines	Rattan S.S	2014	McGraw-Hill Publishing Company

				2014
2.	Mechanisms and Machines-Kinematics, Dynamics and Synthesis	Michael M Stanisic	2016	Cengage Learning 2016

Web links and Video Lectures (e-Resources)

1. https://archive.nptel.ac.in/courses/112/106/112106270/
2. https://nptel.ac.in/courses/112105268
3. https://archive.nptel.ac.in/courses/112/104/112104121

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. Course Seminar
2. Term project
3. Assignment

Semester:	V	**Course Type:**	IPCC		
Course Title:	**TURBO MACHINES**				
Course Code:	**23MEI502**			**Credits:**	04
Teaching Hours/Week (L:T:P:O)			3:0:2:0	**Total Hours:**	40+12 Lab slots
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3hrs

I. Course Objectives:

- Understand typical design of Turbo machine, their working principle, application and thermodynamics process involved.
- Study the conversion of fluid energy to mechanical energy in Turbo machine with utilization factor and degree of reaction.
- Analyze various designs of steam turbines and their working principle.
- Study the various designs of hydraulic turbines based on the working principle.
- Understand the various aspects in design of power absorbing machine.

II. Teaching-Learning Process (General Instructions):

These are sample Strategies that teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different teaching methods to develop the outcomes through presentations/ video demonstrations/ simulations.
- Chalk and talk method for problem-solving.
- Adopt collaborative learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.
- Conduct laboratory demonstrations and practical experiments to enhance experiential skills.

III. COURSE CONTENT

III(a). Theory PART

Module-1	8Hrs

Introduction: Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification, Dimensionless parameters and their significance, Unit and specific quantities, model studies and its numerical. (Note: Since dimensional analysis is covered in Fluid Mechanics subject, the questions on dimensional analysis should not be given. However, dimensionless parameters and model studies may be given more weightage)

Thermodynamics of fluid flow: Application of first and second law of thermodynamics to turbo machines, Efficiencies of turbo machines, Static and Stagnation states, overall isentropic efficiency, stage efficiency (their comparison) and polytropic efficiency for both compression and expansion processes.

Textbook: 1, Chapter 1 and 2, Page No. 1 to 37
Textbook: 2, Chapter 1, Page No. 1 to 53

Pre-requisites: Basic knowledge of fluids and their properties

RBT Levels: L1, L2, L3	
Module-2	8Hrs

Energy exchange in Turbo machines: Euler's turbine equation, Alternate form of Euler's turbine equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor, Problems. **General Analysis of Turbo machines:** Radial flow compressors and pumps – general analysis, Expression for degree of reaction, velocity triangles, Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance, General analysis of axial flow pumps and compressors, degree of reaction, velocity triangles, Numerical Problems.
Textbook: 1, Chapter 3, Page No. 41 to 97 **Textbook: 2, Chapter 2, Page No. 58 to 112**
Pre-requisites: Basic knowledge of energy and conversion efficiencies
RBT Levels: L1, L2, L3

Module-3	8Hrs

Steam Turbines: Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multistage impulse turbine, expression for maximum utilization factor, Numerical. **Reaction turbine:** Parsons's turbine, condition for maximum utilization factor, reaction staging. Numerical.
Textbook: 1, Chapter 4, Page No.105 to 159 **Textbook: 2, Chapter 5, Page No. 184 to 256**
Pre-requisites Basic knowledge of steam formation and properties of steam.
RBT Levels: L1, L2, L3

Module-4	8Hrs

Hydraulic Turbines: Classification, various efficiencies. Pelton Wheel – Principle of working, velocity triangles, design parameters, maximum efficiency, and numerical. **Francis turbine:** Principle of working, velocity triangles, design parameters, and numerical problems Kaplan and Propeller turbines: Principle of working, velocity triangles, design parameters and Numerical. Theory and types of Draft tubes.
Textbook: 1, Chapter 5, Page No.163 to 231 **Textbook: 2, Chapter 6, Page No. 260 to 337**
Pre-requisites : working principle of hydro turbines
RBT Levels: L1, L2, L3

Module-5	8Hrs

Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Theoretical head – capacity relationship, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel. Problems. **Centrifugal Compressors:** Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging and problems
Textbook: 1, Chapter 6 and 7, Page No.237 to 356 **Textbook: 2, Chapter 7 and 8, Page No. 341 to 412**
Pre-requisites : working principle of pump and compressor
RBT Levels: L1, L2, L3

III(b). PRACTICAL PART	
Sl. No.	**Experiments**
1	Performance analysis of Pelton Wheel
2	Performance analysis of Francis turbine
3	Performance analysis of Kaplan turbine
4	Performance analysis of centrifugal blowers
5	Performance analysis of centrifugal pump
6	Performance analysis of Axial Fan
7	Performance analysis of Radial Fan
8	Impact of jet on vanes

Instructions for conduction of practical part:

- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report

IV. COURSE OUTCOMES	
CO1	Apply the Model studies and thermodynamics analysis of turbo machines.
CO2	Explicate the energy transfers in Turbo machine with degree of reaction and utilization factor.
CO3	Analyze and understand various types of steam turbine.
CO4	Analyze and understand various types of hydraulic turbine
CO5	Understand the concept of radial power absorbing machine and the problems involved during its operation.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3	2											3			
CO2	3	2											3			
CO3	3	2											3			
CO4	3	2											3			
CO5	3	2											3			

VI. Assessment Details (CIE & SEE)

General Rules Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section - 2

Semester End Examination (SEE): Refer Annexure section - 2

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Turbo machines	M. S. Govinde Gowda	1st Edn, 2024	Iterative International Publishers (IIP), ISBN: 9789362528841.

2	An Introduction to Energy Conversion, Volume III, Turbo machinery	V. Kadambi and Manohar Prasad	reprint 2008	New Age International Publishers
VII(b): Reference Books:				
1	Fundamentals of Turbo Machinery	B.K Venkanna,	-----	PHI Publishers
2	Turbines, Compressors & Fans	S. M. Yahya	2nd edition, 2002	Tata McGraw Hill Co. Ltd
VII(c): Web links and Video Lectures (e-Resources):				
https://www.tlv.com/global/TI/steamtheory/principalapplicationsforsteam.html https://www.turboindustries.com/ https://www.aeroprobe.com/turbomachineryindustry/ https://www.mrcfd.com/industries/turbomachinery/ https://youtu.be/GIvV6XWaGA https://youtu.be/_6FLj3Zpumo				
VIII: Activity Based Learning / Practical Based Learning/Experiential learning:				
Mention suggested Activities like seminar, assignments, quiz, case studies, mini projects, industry visit, self-study activities, group discussions, etc				

Semester:	V	**Course Type:**	IPCC		
Course Title:	**AUTOMATION IN MANUFACTURING**				
Course Code:	23MEI503			**Credits:**	04
Teaching Hours/Week (L:T:P:O)			3:0:2:0	**Total Hours: (Theory + Lab)**	40+12 Lab slots
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

- To Understand the Fundamentals of Automation in Manufacturing
- To Implement Material Handling and Storage Systems in Automated Environments
- To know the role of automation in enhancing productivity, quality, and efficiency in manufacturing.
- To Understand the overview of automated storage and retrieval systems (ASRS) for inventory management
- To assess the Economic and Environmental Impacts of Automation

II. Teaching-Learning Process (General Instructions):

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.
1.Encourage collaborative (Group Learning) Learning in the class
2. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
3. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
4. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

III. COURSE CONTENT

III(a). Theory PART

Module-1:Introduction &Components for Automation in manufacturing	8 Hrs

Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations.
Components: Sensors and Actuators, Basic principles of hydraulic and pneumatic systems, types of Pumps, Valves, Actuators, and Compressors, Design of hydraulic and pneumatic circuits, Industrial applications and case studies
Textbook1: Chapter1&4 : sections:1.1,1.2,1.4,4.1,4.2,4.3

Pre-requisites (Self Learning)
Basic automation , components in hydraulics & pneumatics

RBT Levels:L1,L2,

Module-2:Automated Manufacturing Systems	8 Hrs

Components of a Manufacturing systems, Classification of Manufacturing Systems, Single Station Manned Workstations and Single Station Automated Cells.
Flexible Manufacturing Systems:FMS Components, FMS Applications & Benefits, and FMS Planning & Implementation Issues
Textbook 1:Chapter 13,14 & 19:Sections 13.1,13.2, 14.1,14.2, 19.1,19.2,19.3

Pre-requisites (Self Learning)
Knowledge about manufacturing systems & flexible**.**

RBT Levels:L1,L2	
Module-3: Material handling and Storage system	8 Hrs
Automated material handling: Types of equipment, functions, analysis and design of material handling systems, conveyor systems, automated guided vehicle systems. **Automated storage systems: Introduction,** Conventional Storage Methods and Equipment Automated storage systems **Automatic Identification and Data Capture:** Overview of Automatic Identification Bar Code Technology, Radio Frequency Identification, Other AIDC Technologies **Textbook 1:Chapter 10,11,12, Section : 10.1,10.2,11.1,11.2,11.3,12.1,12.2,12.3,12.4**	
Pre-requisites (Self Learning) Knowledge about storage system, bar code readers & material handling concepts.	
RBT Levels:L1,L2	
Module-4:Automated Production Lines	8 Hrs
Fundamentals of Automated Production Lines*:* Methods of Work-part Transport, Transfer Mechanism, Storage buffers , Control of the Production Line, Applications of Automated Production Lines **Automated Assembly Systems**: Fundamentals, Types of automated assembly systems, System Configurations, Parts Delivery at Workstations, Applications **Textbook 2: Chapter 16 & 17 Section: 16.1,16.2,17.1,17.2**	
Pre-requisites (Self Learning); Knowledge about storage and production lines	
RBT Levels:L1,L2	
Module-5:Manufacturing Support System	8 Hrs
Process Planning, Computer Aided Process Planning, Advanced Manufacturing Planning, Just-in Time Production System, Basic concepts of lean and Agile manufacturing., Comparisons of Lean & Agile Manufacturing **Textbook 2: Chapter 24& 26Section :24.1,24.2,26.1,26.2**	
Pre-requisites (Self Learning) Lapping, honing, super finishing, Broaching operations	
RBT Levels:L1,L2	

III(b). PRACTICAL PART	
Sl. No.	**Experiments / Programs / Problems**
1	Experimenting with flow control valves to regulate actuator speed-meter in
2	Experimenting with flow control valves to regulate actuator speed-meter out
3	Experimenting on hydraulic motor actuation
4	Electro pneumatic control using solenoid valves any relays in automation
5	Automate the movement of materials along a conveyor using pneumatic actuators
6	Object Detection and Sorting Using Sensors in Automation
7	Experimental working of ultrasonic sensor for Pneumatic Conveyor Belt Automation
8	Demonstrate the operation of an ON-delay timer (TON) in PLC control
9	Demonstrate the operation of an OFF-delay timer (TOF) in PLC control
10	Demonstrate the operation of Automatic reciprocating of pneumatic cylinder using PLC
IV. COURSE OUTCOMES	
CO1	Understand the Fundamentals and Components of Automation Systems

CO2	Analyze and Design Automated Manufacturing Systems
CO3	Implement Material Handling and Storage Solutions in Automation
CO4	Comprehend the fundamentals of automated assembly systems
CO5	Apply Manufacturing Support Systems in Automation

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3	1			2									2		
CO2	3		1		2									2		
CO3	3	2			2									2		
CO4	2		1		2									2		
CO5	2				2									2		

VI. Assessment Details (CIE & SEE)

General Rules Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section –2

Semester End Examination (SEE): Refer Annexure section – 2

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1.	Automation, Production Systems, and Computer-Integrated Manufacturing	Mikell P. Groover	4th Edition (2015)	Pearson Education
2.	Introduction to Automation	R. K. Jain and S. C. Sharma	1st Edition (2008)	Khanna Publishers

VII(b): Reference books:

1	Automation and Manufacturing Systems	K. S. Rajasekaran	1st Edition (2008)	Prentice-Hall India
2	Computer-Integrated Manufacturing	James A. Rehg and Mikell P. Groover	1st Edition (2007)	Pearson Education

VII(c): Web links and Video Lectures (e-Resources):

Mention the links of the online resources, video materials, etc.

- https://onlinecourses.nptel.ac.in/noc22_me123/unit?unit=24&lesson=26
- https://onlinecourses.nptel.ac.in/noc22_me123/unit?unit=39&lesson=40
- https://onlinecourses.nptel.ac.in/noc22_me123/unit?unit=63&lesson=64
- https://onlinecourses.nptel.ac.in/noc22_me123/unit?unit=39&lesson=41

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Conduction of experiments in Centre of excellence : Hydraulics centre, Pneumatics centre, Sensorics centre and PLC centre

Semester:	V	**Course Type:**	PCCL		
Course Title: 3D Printing - CNC Programing Lab					
Course Code:	23MEL504			**Credits:**	01
Teaching Hours/Week (L:T:P:O)			0:0:2:0	**Total Hours:**	14 slots
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	**Practical**			**Exam Hours:**	03

VII. Course Objectives:

- To expose the students to the techniques of CNC programming and cutting tool path generation through CNC simulation software by using G-Codes and M-codes.
- To educate the students on the usage of CAM packages.
- Understand different methods of 3D Printing.
- Gain knowledge about simulation of FDM process
- Estimate time and material required for manufacturing a 3D component

VIII. Teaching-Learning Process (General Instructions):

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various courseoutcomes.

1. Demonstrate ways to solve the same problem and encourage the students to come up with theirown creative solutions.
2. Discuss application of every concept to solve the real world problems.

IX. COURSE CONTETNS

Sl. No.	Experiments
1	Manual CNC part programming using ISO Format G/M codes for 2 turning and 2 milling parts. Selection and assignment of tools, correction of syntax and logical errors, and verification of tool path using CNC program verification software.
2	CNC part programming using CAM packages : Simulation of Turning simulations to be carried out using simulation packages like: Cadem CAMLabPro, MasterCAM.
3	CNC part programming using CAM packages : Simulation of Drilling simulations to be carried out using simulation packages like: CademCAMLabPro, MasterCAM.
4	CNC part programming using CAM packages : Simulation of Milling simulations to be carried out using simulation packages like: CademCAMLabPro, MasterCAM.
5	Internal and external threading : Write a CNC program to create internal and external threading on a cylindrical block(s).
6	Simple 3D Printing Model : Creating Simple 3D model (example cube, gear, prism etc) in CAD software and printing the model using any 3D Printer (FDM/SLA/SLS printer)
7	Assembly Model1: Creating an 3D CAD model of NUT and Bolt (example size M12x50), print the model using any 3D Printer and Check the assembly

8	Assembly Model2: Creating an 3D CAD assembly model containing four or more parts (example Screw jack, plumber block etc) print the model using any 3D Printer and Check the assembly
	Demonstration Experiments (For CIE)
9	Robot programming: Using Teach Pendent & Offline programming to perform pick and place, stacking of objects (2 programs).
10	Pneumatics and Hydraulics, ElectroPneumatics: 3 typical experiments on Basics of these topics to be conducted.
11	FMS (Flexible Manufacturing System): Programming of Automatic storage and Retrieval system (ASRS) and linear shuttle conveyor Interfacing CNC lathe, milling with loading unloading arm and ASRS to be carried out on simple components.
12	Simple strength testing of 3D Printed Parts

X. COURSE OUTCOMES

CO1	Explain the knowledge of G code and M code for machining operations
CO2	Perform CNC programming for turning, drilling, milling and threading operation
CO3	Visualize the 3D models using CAD software's
CO4	Determine effective use of ABS material for 3D Printing
CO5	Understand robotic programming and FMS

XI. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3	2		2	3				2			2	1	2		
CO2	3	2		2	3				2			2	1	2		
CO3	3	2		2	3				2			2	1	2		
CO4	3	2		2	3				2			2	1	2		
CO5	3	2		2	3				2			2	1	2		

XII. Assessment Details (CIE & SEE)

General Rules Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section 4

Semester End Examination (SEE): Refer Annexure section 4

XIII. Learning Resources

VII(a): Textbooks:

Title of the Book	Name of the author	Edition and Year	Name of the publisher
Computer Integrated Manufacturing	Venkateshwaran, N.	2008	PHI Learning Pvt. Ltd
From Idea to Reality: A Comprehensive Guide to 3D Printing	Dr.Abhinav and Dr.C.Anil Kumar	2020	Shashwat Publication

Reference Books			
3D Printing Step by Step	Carmelito Andrade	2022	Notion Press

Web links and Video Lectures (e-Resources)

- https://nptel.ac.in/courses/112102103
- https://onlinecourses.nptel.ac.in/noc19_me46/preview
- https://nptel.ac.in/courses/112103306
- https://archive.nptel.ac.in/courses/112/105/112105211/
- https://onlinecourses.nptel.ac.in/noc20_me50/preview

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. Project based learning

Semester:	V	**Course Type:**	PEC		
Course Title:	**Non Traditional Machining**				
Course Code:	**23MEP511**			**Credits:**	03
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3hrs

I. Course Objectives:

- To learn various concepts related to modern machining processes & their applications.
- To appreciate the differences between conventional and nonconventional machining processes. To acquire a functional understanding of non traditional manufacturing equipment.
- To know about various process parameters and their influence on performance and their applications.
- To impart knowledge on various types of energy involved in non traditional machining processes.

II. Teaching-Learning Process (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Arrange visits to show the live working models other than laboratory topics.
- Adopt collaborative (Group Learning) Learning in the class.
- Adopt Problem Based Learning (PBL), which foster students' Analytical skills and develops Thinking skills such as evaluating, generalizing, and analyzing information.

III. COURSE CONTENT

Module-1:	8Hrs

Introduction to Non traditional machining: Need for Non traditional machining process, Comparison between traditional and non traditional machining, general classification Non traditional machining processes, selection of non-traditional machining processes, Specific advantages, limitations and applications.

Ultrasonic Machining (USM): Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM.

Textbook 1: Chapter:1 Page no: 1-3, Chapter:2 Page no: 7-38

Pre-requisites: Basic knowledge of materials and their properties

RBT Levels: L1,L2	
Module-2:	8Hrs

Abrasive Jet Machining (AJM): Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, standoff distance (SOD). Process characteristics Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM.

Abrasive water Jet Machining (AWJM): Introduction, Principle of working, Applications, advantages & limitations of AJM.

ELECTROCHEMICAL MACHINING (ECM): Introduction, Principle of electro chemical machining, ECM equipment, elements of ECM operation, Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, surface finish. Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of electrolytes. Applications ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages.	
Textbook 1: Chapter:2 Page no: 39-45, Chapter:2 Page no:52-76,	
Pre-requisites : Basic knowledge on application of operation carried on machine tools	
RBT Levels:L1,L2	
Module-3:	8Hrs
CHEMICAL MACHINING (CHM): Elements of the process, Resists (maskants), Etchants. Types of chemical machining process chemical blanking process, chemical milling process. Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process. **PLASMA ARC MACHINING (PAM)**: Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety precautions, applications, advantages and limitations.	
Textbook 1: Chapter:2 Page no:80-84, : Chapter:4 Page no:114-134,	
Pre-requisites: Basic knowledge of cutting fluids, machining & finishing operation	
RBT Levels:L1,L2	
Module-4:	8Hrs
ELECTRICAL DISCHARGE MACHINING (EDM): Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (relaxation type), dielectric mediumits functions & desirable properties, electrode feed control system. EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM, Electrical discharge grinding, Traveling wire EDM. **LASER BEAM MACHINING (LBM):** Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations.	
Textbook 1: Chapter:4 - Page no:84-114, Chapter:4 Page no:143-148	
Pre-requisites : Basic of Machining Process	
RBT Levels: L1,L2	
Module-5:	8Hrs
ELECTRON BEAM MACHINING (EBM): Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations. **Hybrid machining process:** Process principal, process parameters, and application of: Electrochemical Discharge Machining (ECDM), Ultrasonic Assisted Electric Discharge Machining (UAEDM), Electrochemical Discharge Grinding (EDG), Powder Assisted Electric Discharge Machining (PAEDM).	
Textbook 1: Chapter:4 Page no:134-142,	
Pre-requisites : Basics of machining process, NC machine	
RBT Levels: L1,L2	
IV. COURSE OUTCOMES	
CO1	Understand the compare traditional and non traditional machining process and recognize the need for Non traditional machining process.

CO2	Explain the constructional features, performance parameters, process characteristics, applications, advantages and limitations of USM, AJM and WJM.
CO3	Identify the need of Chemical and electrochemical machining process along with the constructional features, process parameters, process characteristics, applications, advantages and limitations.
CO4	Understand the constructional feature of the equipment, process parameters, process characteristics, applications, advantages and limitations EDM & PAM.
CO5	Understand the LBM equipment, LBM parameters, and characteristics. EBM equipment and mechanism of metal removal, applications, advantages and limitations LBM & EBM.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3	1											1			
CO2	3	1											1			
CO3	3	1											1			
CO4	3	1											1			
CO5	3	1											1			

VI. Assessment Details (CIE & SEE)

General Rules Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section - 1

Semester End Examination (SEE): Refer Annexure section - 1

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Modern Machining Process	P.C Pandey and H S Shah,	2000	McGraw Hill Education India Pvt. Ltd. 2000
2	Production technology,	HMT,	2001	McGraw Hill Education India Pvt. Ltd

VII(b): Reference Books:

1	New Technology	Dr. Amitabha Bhattacharyya,	2000	The Institute of Engineers (India)
2	Modern Machining process,	Dr. M Adithan	2002	Khanna Publishers

VII(c): Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=tTnXn498F90&list=PLWv6RLxuaVQwMg6kFEoeeMEGTWNnr7Jmr
2. https://www.youtube.com/watch?v=dmHv42wda9k
3. https://www.youtube.com/watch?v=jwMNNPZejhA&t=23s

Semester:	V	**Course Type:**	PEC		
Course Title:	**Mechatronics**				
Course Code:	**23MEP512**			**Credits:**	03
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3

I. Course Objectives:

1. To acquire a strong foundation in science and focus in mechanical, electronics, control, software, and computer engineering, and a solid command of the newest technologies.
2. To understand the evolution and development of Mechatronics as a discipline.
3. To substantiate the need for interdisciplinary study in technology education
4. To understand the applications of microprocessors in various systems and to know the functions of each element.
5. To demonstrate the integration philosophy in view of Mechatronics technology
6. To be able to work efficiently in multidisciplinary teams.

II. Teaching-Learning Process (General Instructions):

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different teaching methods to develop the outcomes through presentations/ video demonstrations/ simulations.
2. Chalk and talk method for problem-solving.
3. Arrange industrial visits to show the live working models other than laboratory topics.
4. Adopt collaborative learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.
6. Conduct laboratory demonstrations and practical experiments to enhance experiential skills.

III. COURSE CONTENT

Module-1: Introduction to mechatronics	8Hrs

Introduction: Scope and elements of Mechatronics, Mechatronics design process, measurement system, requirements and types of control systems, feedback principle, Basic elements of feedback control systems, Classification of control system. Examples of Mechatronics Systems such as Automatic Car Park system, Engine management system, Antilock braking system (ABS) control, Automatic washing machine.

Transducers and sensors: Definition and classification of transducers, Difference between transducer and sensor, Definition and classification of sensors, Principle of working and applications of light sensors, Potentiometers, LVDT, Airflow rate sensor, Strain Gauge MAP sensor, Engine Crankshaft Angular Position Sensor, Hall effect Position Sensor.

Text book 2: Chapter 1 & 2

Pre-requisites (Self Learning)

1. Basics of Electronics

RBT Levels: L1,L2

Module-2: Signal conditioning and Electromechanical drives	8 Hrs

Signal Conditioning: Introduction – Hardware –Digital I/O, Analog to digital conversions, resolution, Filtering Noise using passive components – Registers, capacitors, amplifying signals using OP amps. Digital Signal Processing – Digital to Analog conversion, Low pass, high pass, notch filtering. Data acquisition systems DAQS). **Electro Mechanical Drives**: Relays and Solenoids – Stepper Motors – DC brushed motors – DC brushless motors – DC servo motors – 4quadrant servo drives, PWM's – Pulse Width Modulation. Text book 2: Chapter 3 and chapter 9	
Pre-requisites (Self Learning) 1. Control system units and components idea 2. Basics of electronics	
RBT Levels: L1,L2	
Module-3: Microprocessor & Microcontrollers:	8Hrs
Microprocessor & Microcontrollers: Introduction, Microprocessor systems, Basic elements of control systems, Microcontrollers, Difference between Microprocessor and Microcontrollers. **Microprocessor Architecture:** Microprocessor architecture and terminology CPU, memory and address, I/O and Peripheral devices, ALU, Instruction and Program, Assembler, Data Registers, Program Counter, Flags, Fetch cycle, write cycle, state, bus interrupts. Intel's 8085A Microprocessor Text book 2: Chapter 17	
Pre-requisites (Self Learning) **1.** Feedback systems **2.** Analog and digital signal systems	
RBT Levels: L1,L2	
Module-4: Programmable Logic Controller:	8Hrs
Programmable Logic Controller: Introduction, Parts of a PLC, Principles of Operation, Modifying the Operation, The I/O Section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, The Central Processing Unit (CPU), Memory Design, Memory Types, Programming Terminal Devices, Recording and Retrieving Data. **PLC Programming language:** PLC programming language, ladder diagram, ladder diagrams circuits, timer counters, internal relays, master control, jump control, shift registers, data handling, PLCs versus Computers, PLC Size and Application. Text book 2: Chapter 21	
Pre-requisites (Self Learning) 1. Basics of CPU 2. Basics of electronics	
RBT Levels: L1,L2	
MODULE 5: Advanced Topics in Automation System Design	8Hrs
Advanced Topics in Automation System Design: Integration of Automation Systems, System integration methodologies and challenges. Design of automated production lines and assembly systems **Control System Design:** Design of control systems for automation using PID and advanced control strategies. Model Predictive Control (MPC) and adaptive control in automation. Case studies of advanced automation systems in industries like automotive, electronics, and healthcare.	
Pre-requisites (Self Learning) 1. Basics of robot configurations 2. Sensors and transducers used in robots Text book 3: Chapter 4	

RBT Levels: L1,L2

IV. COURSE OUTCOMES

CO1	Illustrate various components of Mechatronics systems
CO2	Assess various control systems used in automation.
CO3	Illustrate The architecture of Microprocessor and Microcontroller
CO4	Apply PLC programming for timers, counters using Ladder diagram
CO5	Apply the principles of Mechatronics design to product design.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3	1		2					1				1			
CO2	3	1							1				1			
CO3	3	1		2					1				1			
CO4	3	1							1					3		
CO5	3	1		2					1					1		

VI. Assessment Details (CIE & SEE)

General Rules Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure Section - 1

Semester End Examination (SEE): Refer Annexure Section - 1

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Mechatronics System Design	Devdas Shetty and Richard A Kolk	Second edition,	Thomson Learning Publishing
2	W. Bolton	"Mechatronics"	2007	Addison Wesley Longman Publication, 1999.
3	Shetty and Kolk	"Mechatronics System Design"		Cengage Learning, 2010
4	Frank D Petruzella	Programmable Logic Controllers	4th Edition, 2011	McGraw Hill,

VII(b): Reference Books:

1	Automotive electronics handbook	Ronald K Jurgen	2nd edition 1999	McGraw hill
2	Programmable Logic Controllers	G.Meyer, J.Valldorf and W. Gessener	2009	Springer

VII(c): Web links and Video Lectures (e-Resources):

1. https://www.risetrainingacademy.in/online-offline-autotroics-training.php
2. https://www.udemy.com/course/basics-of-automotive-electronics
3. https://www.rohm.com/applications/automotive/?utm_source
4. https://nptel.ac.in/cources/112103174/4

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Activities like seminar, assignments, quiz, case studies, industry visit, group discussions, etc

Semester:	V	**Course Type:**	PEC		
Course Title:	**Supply Chain Management and Introduction to SAP**				
Course Code:	23MEP513			**Credits:**	03
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

- To acquaint with key drivers of Supply chain performance and their inter-relationship with strategy
- To impart analytical and problem-solving skills necessary to develop solutions for a variety of Supply chain
- To study the complexity of inter-firm coordination in implementing programs such as e-collaboration, quick response, jointly managed inventories and strategic alliances.
- To understand the usage of SAP material management system.

II. Teaching-Learning Process (General Instructions):

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various courseoutcomes.

3. Adopt different type of teaching methods to develop the outcomes through PowerPoint Presentation and Video demonstration or Simulations.
4. Chalk and Talk method for Problem Solving.
5. Discuss the case studies and how every concept can be applied to the real world and when that's possible, it helps improve the students' understanding.
6. Adopt collaborative (Group Learning) Learning in the class.
7. Adopt Problem Based Learning (PBL), which fosters students Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information.

III. COURSE CONTENT

III(a). Theory PART

Module-1:	8Hrs

Introduction:

Supply Chain – Fundamentals –Evolution- Role in Economy - Importance - Decision Phases – Supplier Manufacturer-Customer chain. - Enablers/ Drivers of Supply Chain Performance. Supply chain strategy - Supply Chain Performance Measures.

Text book 1: Chapter 1,2

RBT Levels:L1,L2

Module-2:	8Hrs

Strategic Sourcing Outsourcing –

Make Vs buy - Identifying core processes - Market Vs Hierarchy - Make Vs buy continuum -Sourcing strategy - Supplier Selection and Contract Negotiation. Creating a world class supply base- Supplier Development - World Wide Sourcing.

Text book 1: Chapter 3

RBT Levels: L1,L2

Module-3:	8Hrs

Warehouse Management Stores management-
Stores systems and procedures-incoming materials control stores accounting and stock verification Obsolete, surplus and scrap-value analysis-material handling transportation and traffic management - operational efficiency-productivity-cost effectiveness-performance measurement.
Supply Chain Network Distribution: Network Design – Role - Factors Influencing Options, Value Addition – Distribution Strategies - Models for Facility Location and Capacity allocation. Distribution Center Location Models
Text book 1: Chapter 6
Reference book 1: Chapter 4,5

RBT Levels: L1,L2,L3

Module-4:	8 Hrs

Supply Chain Network optimization models. Impact of uncertainty on Network Design - Network Design decisions using Decision trees. Planning Demand, -multiple item -multiple location inventory management. Pricing and Revenue Management**.**
Reference book 1: Chapter 11,12,13,16

RBT Levels: L1,L2

Module-5:	8 Hrs

Introduction to SAP, SAP Materials Management, Procurement process, Organization structure, Enterprise structure, Master data management, purchase info record, source list, procurement cycle, purchase requisition, request for quotation, purchase order, inventory management, invoice verification, service management, transaction code
Reference Book 2: Chapter 1,2,3,4,6,8,10

RBT Levels: L1,L2

Course outcome (Course Skill Set)

At the end of the course the student will be able to :
1. Describe the framework and scope of supply chain management.
2. Build and manage a competitive supply chain using strategies, models, techniques and information technology.
3. Plan the demand, inventory and supply and optimize supply chain network.
4. Illustrate the emerging trends and impact of IT on Supply chain.
5. Apply the basics of SAP material management system.

IV. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3	3														
CO2	3	3														
CO3	3	3														
CO4	3	3														
CO5	3				2											

V. Assessment Details (CIE & SEE)

General Rules Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section – 1

Semester End Examination (SEE): Refer Annexure section – 1

VI. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1.	Supply chain management	Janat Shah	1st Edition ,1998	1st Edition, Pearson
2.	SAP	Ashfaque Ahmed	2014	Auerbach Publications, New York
Reference Books:				
1.	Supply chain management	Sunil Chopra and Peter Meindl	6th Edition ,2016	Pearson Education
2.	SAP	Martin Murray and Jawad Akhtar	4th edition,2024	Rheinwerk Publishing

Web links and Video Lectures (e-Resources)

4. https://onlinecourses.nptel.ac.in/noc21 mg45/preview
5. https://nptel.ac.in/courses/110106045
6. https:// nptel.ac.in/courses/110105095

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

2. Case study of companies' example Amazon, Flipkart, Parle, DMart, Reliance etc can be discussed

Semester:	V	**Course Type:**	PEC		
Course Title:	**ENERGY INTELLIGENCE**				
Course Code:	23MEP514			**Credits:**	03
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

- Provide a comprehensive understanding of traditional and advanced steam generation technologies, including modern boiler systems and emission control strategies.
- Introduce students to various renewable energy sources such as solar, biomass, geothermal, tidal, and wind energy, along with their latest technological advancements.
- Analyze the principles and applications of hydroelectric and ocean energy systems, including energy efficiency improvements and environmental impact assessments.

II. Teaching-Learning Process (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

8. Use of Chalk and Talk method
9. Video lectures, lecture projections in class
10. Individual and Group assignments

III. COURSE CONTENT

III(a). Theory PART

Module-1: 8Hrs

- **Steam Generators and Advanced Boiler Technologie:** Coal and ash handling, Generation of steam using forced circulation, high and supercritical pressures LaMount, Benson, Velox, Loeffer, Schmidt steam generators Cooling towers and Ponds **Accessories:** Superheaters, De-superheater, Economizers, Air preheaters **Modern boiler technologies:** Fluidized bed combustion, Waste heat recovery boilers Boiler performance evaluation, Efficiency improvement techniques Emission control strategies in thermal power plants Carbon capture and storage (CCS) in steam power plants

Text book 1: Chapter 1- 1.1, 1.2, 1.3,1.4,1.5,1.6 Chapter 2- 2.1, 2.2, 2.3, 2.4, 2.5,2.6,2.7,2.8,2.9

RBT Levels: L1, L2

Module-2: 8Hrs

Solar and Biomass Energy; Introduction, Solar radiation at the earth's surface, Solar radiation measurements Flat plate collectors, Focusing collectors, Solar pond Solar electric power generation: Solar photovoltaics

Biomass Energy: Photosynthesis, photosynthetic oxygen production, energy plantation Bio Chemical Route: Biogas production from organic wastes by anaerobic fermentation, Bio gas plants (KVIC, Janta, Deenbhandu models), factors affecting biogas generationThermal gasification of biomass, updraft and downdraft Hybrid solar-biomass power generation,

Advances in biofuels Concentrated solar power (CSP) technologies and thermal storage Solar energy-based desalination techniques Waste-to-energy conversion methods **Text book 1**: Chapter 3- 3.1, 3.2, 3.3,3.4,3.5,3.6,3.7,3.8,3.9 Chapter 4- 4.1, 4.2, 4.3, 4.4, 4.5,4.6,4.7,4.8,4.9,4.10	
RBT Levels: L1, L2	
Module-3:	8 Hrs
Geothermal, Tidal, and Wind Energy: Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, **Forms of geothermal energy:** Dry steam, wet steam, hot dry rock, and magmatic chamber systems Tidal power: Site selection, Single basin and double basin systems, Advantages and disadvantages Wind energy: Advantages and limitations, Wind velocity and wind power Basic components of wind energy conversion systems, Horizontal and vertical axis wind mills Coefficient of performance of a wind mill rotor, Applications of wind energy Offshore wind energy systems, Enhanced geothermal systems (EGS)Floating wind turbines and advancements in turbine technology **Text book 1**: Chapter 14- 14.1, 14.2, 14.3,14.4,14.5,14.6,14.7,14.8,14.9,14.10, ,14.22,14.23	
RBT Levels: L1, L2	
Module-4:	8 Hrs
Hydroelectric and Ocean Thermal Energy; Hydroelectric plants: Advantages & disadvantages, Hydrographs and flow duration curves (numerical)Storage and pondage, General layout of hydel power plants, Components: Penstock, surge tanks, spillway, draft tube Pumped storage plants, Detailed classification of hydroelectric plants, Water hammer Ocean thermal energy conversion (OTEC): Principle, Problems associated with OTEC Small and micro hydropower systems, Marine and wave energy conversion Energy efficiency improvements in hydroelectric plants Environmental impact assessment of hydro and ocean energy projects Hybrid hydro-solar and hydro-wind systems. **Text book 2**: Chapter 9- 9.1,9.2,9.3 Chapter 12- 12.1,12.2,12.3,12.4,12.5	
RBT Levels: L1, L2	
Module-5:	8 Hrs

- **Nuclear Energy and Emerging Technologies:** Principles of nuclear energy release: Fusion and fission reactions Nuclear fuels, Chain reaction, Moderation, Breeding, Multiplication, and thermal utilization factors General components of a nuclear reactor and materials **Brief description**: Pressurized water reactor, Boiling water reactor, Sodium graphite reactor, Fast Breeder reactor, Homogeneous graphite reactor, Gas-cooled reactor Advanced nuclear reactors: Small Modular Reactors (SMRs), Thorium-based reactors Nuclear fusion technology and ITER project Hydrogen energy technology and fuel cells Safety regulations and policies in nuclear energy Radiation hazards, Shielding, Nuclear waste, Radioactive waste disposal
  Chapter 14-14.1,14.2,14.3,14.4

RBT Levels: L1, L2

IV. COURSE OUTCOMES

CO1	Understand the construction and working of steam generators and modern boiler technologies
CO2	Identify renewable energy sources and their utilization in emerging energy systems.
CO3	Analyze energy conversion principles from alternative sources including wind, geothermal, ocean, biomass, nuclear, hydro, and tidal energy.
CO4	Explore advancements in modern power plants, hybrid energy systems, and clean energy solutions
CO5	Evaluate the efficiency, environmental impact, and future potential of various energy conversion technologies

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3	3	3	3	2								1			
CO2	3	3	3	3	2								1			
CO3	3	3	3	3	2								1			
CO4	3	3	3	3	2								1			
CO5	3	3	3	3									1			

VI. Assessment Details (CIE & SEE)

General Rules Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section – 1

Semester End Examination (SEE): Refer Annexure section – 1

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher

1.	Power Plant Engineering	- P. K. Nag,	2012.	Tata McGraw Hill, 3rd Edition,
2.	Non-Conventional Sources of Energy	- G. D. Rai,	2015	Khanna Publishers, 5th Edition,
Reference Books				
1.	Power Plant Engineering	R. K. Rajput,	2012	Laxmi Publications.
2.	Principles of Energy Conversion	A. W. Culp Jr,	1996	McGraw Hill,
Web links and Video Lectures (e-Resources) https://nptel.ac.in/courses/112106186				
VIII: Activity Based Learning / Practical Based Learning/Experiential learning:				
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning Case Study Discussions, Mini Project, Debates & Presentations, Data Analysis Activity, Field Survey Project				

Semester:	V	**Course Type:**	ETC		
Course Title:	**Introduction to Artificial Intelligence**				
Course Code:	23MEE531			**Credits:**	03
Teaching Hours/Week (L:T:P:O)			2:0:2:@	**Total Hours:**	25 + 12 Lab slots
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

- Gain a historical perspective of AI and its foundations.
- Become familiar with basic principles of AI toward problem solving
- Get to know approaches of inference, perception, knowledge representation, and learning

II. Teaching-Learning Process (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various courseoutcomes.

11. Lecturer methods (L) need not to be only traditional lecture method, but alternative effectiveteaching methods could be adopted to attain the outcomes.
12. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop designthinking skills such as the ability to design, evaluate, generalize, and analyze information ratherthan simply recall it.
13. Introduce Topics in manifold representations.
14. Demonstrate ways to solve the same problem and encourage the students to come up with theirown creative solutions.
15. Discuss application of every concept to solve the real world problems.

III. COURSE CONTENT

III(a). Theory PART

Module-1:	5Hrs
Introduction to AI, Foundations and History of AI **Intelligent Agents:** Agents andenvironment, Concept of Rationality, The nature of environment, The structure of agents**.** **Text book 1**: Chapter 1- 1.1, 1.2, 1.3 Chapter 2- 2.1, 2.2, 2.3, 2.4	
RBT Levels: L1,L2	
Module-2:	5Hrs
Problem solving: Problem solving agents, Example problems, Searching for Solutions Uninformed Search Strategies: Breadth First search, Depth First Search, Iterative deepening depth first search; **Text book 1**: Chapter 3- 3.1, 3.2, 3.3, 3.4	
RBT Levels: L1,L2	
Module-3:	5Hrs
Informed Search Strategies: Heuristic functions, Greedy best first search, A*search. Heuristic Functions **Logical Agents**: Knowledge–based agents, The Wumpus world, Logic, Propositional logic, Reasoningpatterns in Propositional Logic **Text book 1**: Chapter 3-3.5,3.6 Chapter 4 – 4.1, 4.2 Chapter 7- 7.1, 7.2, 7.3, 7.4, 7.5	
RBT Levels: L1,L2,L3	
Module-4:	5 Hrs
First Order Logic: Representation Revisited, Syntax and Semantics of First Order logic, Using First	

Orderlogic. **Inference in First Order Logic** :Propositional Versus First Order Inference, Unification, Forward Chaining, Backward Chaining, Resolution

Text book 1: Chapter 8- 8.1, 8.2, 8.3 Chapter 9- 9.1, 9.2, 9.3, 9.4, 9.5

RBT Levels: L1,L2

Module-5: 5Hrs

Uncertain Knowledge and Reasoning: Quantifying Uncertainty: Acting under Uncertainty, Basic Probability Notation, Inference using Full Joint Distributions, Independence, Baye's Rule and its use. Wumpus World Revisited

Expert Systems: Representing and using domain knowledge, ES shells. Explanation, knowledge acquisition

Text Book 1: Chapter 13-13.1, 13.2, 13.3, 13.4, 13.5, 13.6

Text Book 2: Chapter 20

RBT Levels: L1,L2

III(b). PRACTICAL PART

Sl. No.	Programs
1	Implement and Demonstrate Depth First Search Algorithm on Water Jug Problem
2	Implement and Demonstrate Best First Search Algorithm on Missionaries-Cannibals Problems usingPython
3	Implement A* Search algorithm
4	Implement AO* Search algorithm
5	Solve 8-Queens Problem with suitable assumptions
6	Implementation of TSP using heuristic approach
7	Implementation of the problem solving strategies: either using Forward Chaining or Backward Chaining
8	Implement resolution principle on FOPL related problems

IV. COURSE OUTCOMES

CO1	Apply knowledge of agent architecture, searching and reasoning techniques for different applications
CO2	Compare various Searching and Inferencing Techniques
CO3	Develop knowledge base sentences using propositional logic and first order logic
CO4	Describe the concepts of quantifying uncertainty
CO5	Use the concepts of Expert Systems to build applications

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3	3			3									2		
CO2	3	3			3									2		
CO3	3	3			3									2		
CO4	3	3			3									2		
CO5	3	3			3									2		

VI. Assessment Details (CIE & SEE)

General Rules Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section – 2

Semester End Examination (SEE): Refer Annexure section – 2

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1.	Artificial Intelligence	Stuart J. Russell and Peter Norvig	2015	3rd Edition, Pearson
2.	Artificial Intelligence	Elaine Rich, Kevin Knight	2013	3rd edition,Tata McGraw Hill
Reference Books				
1.	Artificial Intelligence Structure and strategies for complex	George F Lugar	2011	Pearson Education, 5th Edition
2.	Principles of Artificial Intelligence	Nils J. Nilsson	1980	Elsevier
3.	Artificial Intelligence	Saroj Kaushik	2014	Cengage learning

Web links and Video Lectures (e-Resources)

7. https://www.kdnuggets.com/2019/11/10-free-must-read-books-ai.html https://www.udacity.com/course/knowledge-based-ai-cognitive-systems--ud409 3. https://nptel.ac.in/courses/106/105/106105077/

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

3. Group discussion on Real world examples
4. Project based learning

Simple strategies on gaming, reasoning and uncertainty etc

Semester:	V	**Course Type:**	ETC		
Course Title: Robotics and Automation					
Course Code:	**23MEE532**		**Credits:**		3
Teaching Hours/Week (L:T:P:O)			3:0:0:@	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3

I. Course Objectives:

This course will enable students:
1. To Understand the Fundamentals of Robotics and Automation
2. To develop Skills in Robot Programming and Control
3. To explore various real-world applications of robotics and automation
4. To develop hands-on skills by designing, building, and testing simple robotic systems

II. Teaching-Learning Process (General Instructions):

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.
1. Adopt different teaching methods to develop the outcomes through presentations/ video demonstrations/ simulations.
2. Chalk and talk method for problem-solving.
3. Adopt collaborative learning in the class.
4. Conduct laboratory demonstrations and practical experiments to enhance experiential skills.

III. COURSE CONTENT

III(a).Theory PART

Module-1: Industrial Robotics:	8 Hrs

Robotic configuration, robot anatomy, work volume, robot drive systems, end effectors, sensors in robotics, industrial robot applications, robot accuracy and repeatability, different types of robots, various generations of robots, degrees of freedom – Asimov's laws of robotics, dynamic stabilization of robots.

Textbook:1, Chapter:2, sections:2.1 -2.9

Pre-requisites (Self Learning): Elements of Mechanical Engineering

RBT Levels: L1,L2

Module-2: Spatial descriptions and transformations	8 Hrs

Robot actuators and Feedback components:
Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors, comparison. Position sensors –potentiometers, resolvers, encoders –Velocity sensors, Tactile sensors, Proximity sensors. Manipulator Kinematics: Homogeneous transformations and robot kinematics. Configuration of a robot controller

Textbook:1, Chapter: 3&4, sections: 3.1-3.9 & 4.1-4.5

Pre-requisites (Self Learning): Elements of Mechanical Engineering, hydraulics & pneumatics basics

RBT Levels: L1, L2

Module-3: Robot Programming and industrial robot application	8 Hrs

Robot programming methods, lead through programming methods, motion interpolation, Robot language structure, robot language elements & function: problems on programing

Material handling application: material transfer, machine loading & un loading.
Process operations: Spot welding, Arc welding, Spray coating, assembly & inspection
Characteristics of robot application

Textbook:1, Chapter:8,13 &14, sections:8.1 – 8.4,13.1-13.3,14.1-14.3,15

Pre-requisites (Self Learning): Types of modes in material handling

RBT Levels: L1, L2

Module-4: Introduction to automation	8 Hrs

Basic elements of an automated system, advanced automation functions, levels of automation, process industries versus discrete manufacturing industries, continuous versus discrete control, computer process control. Hardware components for automation and process control, sensors, actuators, analog to digital converters, digital to analog converters, input/output devices for discrete data

Textbook:3, Chapter: 1&4, sections: 1.1-1.4,4.1-4.3

Pre-requisites (Self Learning): Knowledge of mechanical systems, sensor control system

RBT Levels: L1, L2,L3

Module-5: Future of Automated Factory	8 Hrs

Industry 4.0, functions, applications and benefits. Components of Industry 4.0, Internet of Things (IOT), IOT applications in manufacturing, Flexible Manufacturing Systems, types of FMS, FMS components, Automated Storage and Retrieval Systems, AS/RS and Automatic parts identification systems and data capture.

Textbook:3, Chapter:19, sections:19.1-19.3,

Pre-requisites (Self Learning): Basics of IOT and automation in manufacturing

RBT Levels:L2,L3

IV. COURSE OUTCOMES

CO1	Impart fundamental principles of robotics in industry
CO2	Analyse robotic systems, evaluating their functionality, efficiency, and performance in real-world scenarios
CO3	Incorporate programming and control system to operate robotic systems
CO4	Understand fundamental principles of automation
CO5	Visualize and appreciate the modern trends in Manufacturing like additive manufacturing, Industry 4.0 and applications of Internet of Things leading to Smart Manufacturing

V. CO-PO-PSO MAPPING(mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3		1		2									2		
CO2	3	1		1	2									2		
CO3	3		1		2									2		
CO4	3		1		2									2		
CO5	3													2		

VI. Assessment Details (CIE & SEE)

General Rules Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section – 1

Semester End Examination (SEE): Refer Annexure section - 1				
VII. Learning Resources				
VII(a): Textbooks:				
Sl. No.	**Title of the Book**	**Name of the author**	**Edition and Year**	**Name of the publisher**
1	Industrial robotics	Mikell P. Groover	2nd Edition,2012	McGraw-Hill.
2	Robotics	Appuu Kuttan KK	2020	Dreamtech Press
3	Automation, Production Systems, and Computer-Integrated Manufacturing	Mikell P. Groover	4th edition	Pearson
4	Introduction to robotics mechanics and control	John J. Craig	3rd edition, 2009	Pearson
VII(b): Reference Books:				
1	Industrial Robotics Weiss	Nagel	2nd edition, 2012	McGraw Hill International
2	Robotic Engineering	Klafter, Chmielewski and Negin	**- 1st edition, 2009**	PHI
3	Fundamentals of Pneumatics/electro-pneumatics	Hasebrink J.P., and Kobler R	-	FESTO Didactic PublicationNo. 7301, Esslingen Germany
VII(c): Web links and Video Lectures (e-Resources):				
Robot Drive Systems : https://www.youtube.com/watch?v=wHNq8SEPZHA Introduction to Hydraulic and Pneumatic Systems : https://nptel.ac.in/courses/112105047 Electrical Actuation System : https://www.youtube.com/watch?v=YBpfLWTE6ak				
VIII: Activity Based Learning				
Activities like seminar/assignments/quiz				

Semester:	V	**Course Type:**	ETC		
Course Title:	**Electric and Hybrid Vehicle Technology**				
Course Code:	23MEE533			**Credits:**	03
Teaching Hours/Week (L:T:P:O)			3:0:0:@	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

- To understand the models, describe hybrid vehicles and their performance.
- To understand the different possible ways of energy storage.
- To understand the different strategies related to hybrid vehicle operation & energy management.

II. Teaching-Learning Process (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.

Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.

III. COURSE CONTENT

III(a). Theory PART

Module-1:	8Hrs

Introduction to Electric Vehicle (EV) & Hybrid Vehicle (HV):

A brief history of Electric and Hybrid vehicles, basic architecture of hybrid drive train, types of HV and EV, advantages over conventional vehicles, limitations of EV and HV, impact on environment of EV and HV technology, disposal of battery, cell and hazardous material and their impact on environment.

Textbook 1: Chapter 1

RBT Levels: L1,L2

Module-2:	8Hrs

Power Management and Energy Sources of EV and HV:

Power and Energy management strategies and its general architecture of EV and HV, various battery sources, energy storage, battery-based energy storage, Battery Management Systems (BMS), fuel cells, their characteristics, Super capacitor based energy storage, flywheel, hybridization of various energy storage devices, Selection of the energy storage technology.

Textbook 1: Chapter 2 & 3

RBT Levels: L1,L2,L3

Module-3:	8 Hrs

DC and AC Machines & Drives in EV & HV:

Various types of motors, selection and size of motors, **Induction** motor drives and control characteristics, **Permanent** magnet motor drives and characteristics, **Brushed & Brushless** DC motor drive and characteristics, **switched reluctance motors** and characteristics, mechanical and electrical connections of motors.

Textbook 1: Chapter 3

RBT Levels: L1,L2,L3

Module-4:	8 Hrs

Components & Design Considerations of EV & HV:

Design parameters of batteries, ultra-capacitors and fuel cells, aerodynamic considerations, calculation of the rolling resistance and the grade resistance, calculation of the acceleration force, total tractive effort, torque required on the drive wheel, transmission efficiency, consideration of vehicle mass.

Textbook 1: Chapter 2 & 4

RBT Levels: L1,L2,L3

Module-5:	8 Hrs

Electric and Hybrid Vehicles charging architecture:

Introduction to smart charging: Grid to vehicle and vehicle to grid, smart metering and ancillary services, introduction to battery charging stations and its installation and commissioning, preliminary discussion on estimation on station capacity and associated technical issues, different connectors.

Textbook 1: Chapter 5

RBT Levels: L1,L2

IV. COURSE OUTCOMES

CO1	Comprehend vehicle dynamics of electric and hybrid vehicles
CO2	Analyse the power management systems for electric and hybrid vehicles
CO3	Enumerate motor control strategies for electric and hybrid vehicles
CO4	Analyse various components of electric and hybrid vehicles with environment concern.
CO5	Estimate the domain related grid interconnections of electric and hybrid vehicle.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3						2						1			
CO2	3		2										2			
CO3	3												1			
CO4	3		2										1			
CO5	3						2						-			

VI. Assessment Details (CIE & SEE)

General Rules Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section – 1

Semester End Examination (SEE): Refer Annexure section – 1

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1.	Electric and Hybrid Vehicles Design Fundamentals	Iqbal Hussain	2003	1st Edition, CRC Press
2.	Electric Vehicle Technology Explained	James Larminie, John Lowry	2003	1st Edition, John Wiley and Sons
	Reference Books			
1.	Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives	Chris Mi, M. Abul Masrur, David Wenzhong Gao	2011	Wiley publication
2.	Hybrid Vehicles and the future of personal transportation	Allen Fuhs	2009	CRC Press

Website links
https://nptel.ac.in/courses/108/103/108103009/
https://nptel.ac.in/courses/108/102/108102121/

VIII : Activity Based Learning/Practical based learning/Experimental Learning

Activity Based Learning (Suggested Activities in Class)Group discussion on Real world examples/presentation/Assignments

Semester:	V	**Course Type:**	ETC		
Course Title:	**OPTIMIZATION TECHNIQUES**				
Course Code:	**23MEE534**			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3:0:0:@	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3

I. Course Objectives:

- To expose the students to techniques to optimize complex engineering problems.
- To introduce non-linear programming techniques.
- To introduce the Integer programming method.

II. Teaching-Learning Process (General Instructions):

- Chalk and talk method
- PowerPoint Presentation
- Videos

III. COURSE CONTENT

Module-1: Introduction — 08 Hrs

Introduction: Statement of optimisation problem, Design vector, Design constraints, Objective function, Classification of optimisation problems based on :constraints, nature of design variables, nature of the equations involved Single variable optimisation: Necessary and sufficient conditions, Multivariable optimization with no constraints: Necessary and sufficient conditions, Semi definite case, Saddle point, Multi variable optimization with equality constraints, Solution by direct substitution, Lagrange Multipliers, Interpretation of Lagrange multipliers, Multivariable optimization with inequality constraints: Khun Tucker conditions(concept only).

Textbook: 01, Chapter- 2

Pre-requisites (Self Learning): Fundamentals of Mathematics

RBT Levels: L1, L2

Module-2: Nonlinear Programming - One-Dimensional Minimization Method — 08 Hrs

Nonlinear Programming: One-Dimensional Minimization Methods, Introduction, Unimodal Function, Elimination methods: unrestricted search, fixed step size, accelerated step size, Exhaustive search: dichotomous search, interval halving method, Fibonacci method, golden section method, Interpolation methods: Quadratic and cubic interpolation method, direct root method, Newton method, Quasi Newton method, secant method.

Textbook: 01 Chapter: 5

Pre-requisites (Self Learning): Fundamentals of Mathematics

RBT Levels: L1, L2

Module-3: Nonlinear Programming - Direct search method — 08 Hrs

Nonlinear Programming: Direct search methods: Classification of unconstrained minimization methods, rate of convergence, scaling of design variables, random search methods, univariate methods, pattern directions, Powell's methods, Simplex method.

Textbook: 01 Chapter: 6

Pre-requisites (Self Learning): Fundamentals of Mathematics

RBT Levels: L1, L2

Module-4: Nonlinear Programming - Indirect Search (Descent) Method — 08 Hrs

Nonlinear Programming: Indirect Search (Descent) Methods: Gradient of a function, Steepest decent method, Fletcher Reeves method, Newton's method, Davidson-Fletcher-Powell method.

Textbook: 01 Chapter: 6

Pre-requisites (Self Learning): Fundamentals of Mathematics

RBT Levels: L1, L2

Module-5: Integer Programming 08 Hrs

Integer Programming: Introduction, Graphical representation, Gomory's cutting plane method: concept of a cutting plane, Gomory's method for all-integer programming problems, Bala's algorithm for zero–one programming, Branch-and-Bound Method.

Textbook: 01 Chapter: 10

Pre-requisites (Self Learning): Fundamentals of Mathematics

RBT Levels: L1, L2

IV. COURSE OUTCOMES

CO1	Define and use optimization terminology, concepts, and understand how to classify an optimization problem
CO2	Understand how to classify an optimization problem
CO3	Apply the mathematical concepts formulate the problem of the systems.
CO4	Analyse the problems for optimal solution using the algorithms
CO5	Interpret the optimum solution

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3	2											1			
CO2	3	2											1			
CO3	3	2											1			
CO4	3	2											1			
CO5	3	2											1			

VI. Assessment Details (CIE & SEE)

General Rules Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Engineering Optimization Theory and Practice	S. S. Rao	Fourth Edition 2009	John Wiley & Sons
2	Optimisation Concepts and Applications in Engineering	A. D. Belegundu, T.R. Chanrupatla,	2011	Cambridge University Press

VII(b): Reference Books:

1	Engineering Optimization: Methods and Applications	Ravindran, K. M. Ragsdell, and G. V. Reklaitis	2nd ed. 2006	Wiley, New York

VII(c): Web links and Video Lectures (e-Resources):

NPTEL: Course Introduction - Optimization from fundamentals
https://youtu.be/np69oWY4U94?si=3We-GwR9PrsEBJSm
https://youtu.be/gw_ZEUjI9KM?si=6HZ8sUWx5mxiNQyU
https://youtu.be/84HOL_EiJ4M?si=4W9NUBGPW75opcYk

VIII: Activity Based Learning:

- Quizzes
- Assignments
- Seminars

Semester:	V	**Course Type:**	AEC		
Course Title: **Industrial Internet of Things**					
Course Code:	**23MEAE51**			**Credits:**	01
Teaching Hours/Week (L:T:P:O)			0:0:2:0	**Total Hours:**	14 Slots
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Practical			**Exam Hours:**	03

I. Course Objectives: Student will be able to

1. To impart necessary and practical knowledge of components of Internet of Things
2. To develop skills required to build real-life IoT based projects.

Pre requisites (Self Learning)

1. **Basics of C Programming Language**

II. Teaching-Learning Process (General Instructions):

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different teaching methods to develop the outcomes through presentations/ video demonstrations/ simulations.
2. Chalk and talk method for problem-solving.
3. Adopt collaborative learning in the class.
4. Conduct laboratory demonstrations and practical experiments to enhance experiential skills.

III. COURSE CONTENT

Sl. No.	Exercises
1	i) To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to 'turn ON' LED for 1 sec after every 2 seconds. ii) To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to 'turn ON' LED when push button is pressed or at sensor detection.
2	i) To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings. ii) To interface OLED with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.
3	To interface motor using relay with Arduino/Raspberry Pi and write a program to 'turn ON' motor when push button is pressed.
4	(i) Write an Arduino/Raspberry Pi program to interface the Soil Moisture Sensor. (ii) Write an Arduino/Raspberry Pi program to interface the LDR/Photo Sensor.
5	Write a program to interface an Ultrasonic Sensor with Arduino /Raspberry Pi
6	Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to thing speak cloud.
7	Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from thing speak cloud
8	Write a program to interface LED using Telegram App
9	Write a program to create UDP server on Arduino/Raspberry Pi and respond with humidity data to UDP client when requested

10	Write a program on Arduino/Raspberry Pi to subscribe to MQTT broker for temperature data and print it.

RBT Levels: L2, L3, L4

IV. COURSE OUTCOMES

CO1	Understand internet of Things and its hardware and software components
CO2	Interface I/O devices, sensors & communication modules
CO3	Remotely monitor data and control devices
CO4	Develop real life IoT based projects

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3				1	1	1			2				2		
CO2	3	2	2	1	3	3	2			2				2		
CO3	3	2	2	1	3	3	2			2				2		
CO4	3	3	3	3	3	3	2			2				2		

VI. Assessment Details (CIE & SEE)

General Rules Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section – 4

Semester End Examination (SEE): Refer Annexure section - 4

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Internet of Things. "A Hands-on Approach"	Vijay Madisetti, Arshdeep Bahga	2015	University Press
2	"Introduction to Internet of Things: A Practical Approach	Dr. SRN Reddy, Rachit Thukral, and Manasi Mishra	---	ETI Labs

VII(b): Reference Books:

1	Internet of Things	Jeeva Jose	**2023**	Khanna Publishing House, Delhi

VII(c): Web links and Video Lectures (e-Resources):

Mention the links of the online resources, video materials, etc.

1. https://www.youtube.com/watch?v=EJEz6t5SpMw
2. https://www.youtube.com/watch?v=Mp7_pLAuTPo
3. https://www.youtube.com/watch?v=GOO84CGBPz8
4. https://www.youtube.com/watch?v=p7kYStiASLo&list=PLbRMhDVUMngdcLdH4-YF1uJI4IuhcDZPR
5. https://archive.nptel.ac.in/courses/106/105/106105195/

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

suggested Activities: case studies, mini projects, self-study activities, etc.

Semester:	V	**Course Type:**	AEC		
Course Title:	**INTRODUCTION TO DATA ANALYTICS**				
Course Code:	23MEAE52			**Credits:**	01
Teaching Hours/Week (L:T:P:O)			0:0:2:0	**Total Hours:**	14 Lab slots
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	**Practical**			**Exam Hours:**	03

I. Course Objectives:

- To understand Numpy, Pandas and Matplot library
- To understand basics of statistics
- To learn the basic of decision tree algorithm.
- To understand random forest algorithm and Anova
- To use Python data structures.
- To use excel in data analytics

II. Teaching-Learning Process (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various courseoutcomes.

16. Introduce Topics in manifold representations.
17. Demonstrate ways to solve the same problem and encourage the students to come up with theirown creative solutions.
18. Discuss application of every concept to solve the real world problems.

III. COURSE CONTENT

Sl. No.	Experiments
1	Use Numpy to create single and multi-dimensional array and perform various operations using Python.
2	Use Pandas to access dataset, cleaning, manipulate data and analyze using Python
3	Use matplot library to plot graph for data visualization using Python
4	Determine probability, sampling and sampling distribution using Python
5	Determine frequency distributions, variability, average, and standard deviation using Python
6	Draw normal curves, correlation, correlation coefficient and scatter plots using Python
7	Implement and analyze Linear regression in Python (Single variable & Multivariable)
8	Implement and analyze Logistic regression in Python
9	Implement and analyze Decision tree algorithm in Python
10	Implement and analyze Random Forest algorithm in Python

Only for CIE

11	Implementation of two samples T-test and paired two-sample T-test in excel.
12	Implementation of one-way and two-way ANOVA in excel.

IV. COURSE OUTCOMES

CO1	Analyze data using tools and represent for visualization
CO2	Implement various statistical methods.
CO3	Understand and use decision tree and random forest algorithm
CO4	Understand and Implement T test and Anova.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3	3			3									2		
CO2	3	3			3									2		
CO3	3	3			3									2		
CO4	3	3			3									2		

VI. Assessment Details (CIE & SEE)

General Rules Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section – 4

Semester End Examination (SEE): Refer Annexure section - 4

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1.	Python for data analysis: Data wrangling with Pandas, NumPy, and IPython	McKinney, W	2012	O'Reilly Media, Inc.

Reference Books

1.	Business Statistics for Contemporary Decision Making	Ken Black	2010	John Wiley & Sons, Inc"

Web links and Video Lectures (e-Resources)

- https://www.simplilearn.com/tutorials/data-analytics-tutorial/data-analytics-with-python

https://www.youtube.com/watch?v=GPVsHOlRBBI&ab_channel=freeCodeCamp.org

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

5. Project based learning

Semester:	V	**Course Type:**	AEC		
Course Title: **Finance for Engineers**					
Course Code:	23MEAE53			**Credits:**	01
Teaching Hours/Week (L:T:P:O)			0:2:0:0	**Total Hours:**	30
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	**Theory**			**Exam Hours:**	03

VIII. Course Objectives:

- Provide an overview of financial engineering and the process involved therein
- Focus on newly emerging fixed income products
- Focus on newly emerging equity products

IX. Teaching-Learning Process (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various courseoutcomes.

19. Sets out to show how finance interacts with engineering and why it matters.
20. Expert talk
21. Practical Case study

X. COURSE CONTENT

Module 1

Basics of Accounting Debit, Credit, Books of accounts, Ledgers Cash flow statements, Assets and Liabilities.
Text book 1: Chapter 5

RBT Levels: L1,L2

Module 2

Understanding Balance Sheet and Profit & Loss Statement of Companies with Examples of actual Balance Sheets of Small, Medium, Large Size Companies.
Text book 1: Chapter 3.5

RBT Levels: L1,L2

Module 3

Conceptual Understanding of Cost, Expense, Gross & Net Profit, ROI, Dividend, Depreciation, Taxes, Duties, Reserves, Insurance
Text book 1: Chapter 2

RBT Levels: L1,L2

Module 4

Finance for Startups- Govt Schemes / PSU &PSE Bank Finance, Bank Scrutiny for approvals etc.
Text book 1: Chapter Part IV

RBT Levels: L1,L2

Module 5

Project Budgeting, and Importance of tracking cost of projects in execution
Text book 1: Chapter 4

RBT Levels: L1,L2

XI. COURSE OUTCOMES

CO1	Understand essential financial concepts and terminology
CO2	Understand the interrelationship of key financial variables and metrics
CO3	Understand accounting systems and analyze financial statements

CO4	Apply the concepts of financial management for project appraisal

XII. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	2	1									2					
CO2	2	1									2					
CO3	2	1									2					
CO4	2	1									2					

XIII. Assessment Details (CIE & SEE)

General Rules Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section – 4

Semester End Examination (SEE): Refer Annexure section - 4

XIV. Learning Resources

VII(a): Textbooks:

Sl. No.	**Title of the Book**	**Name of the author**	**Edition and Year**	**Name of the publisher**
1.	Finance for Engineers	F.K. Crundwell	13 October 2010	ISBN-13 978-1848000322 Springer
Reference Books				
2.	Financial Fundamentals for Engineers	Ken Black	2010	ISBN: 9780750669412 **Taylor & Francis Ltd**

Web links and Video Lectures (e-Resources)

1. https://www.youtube.com/watch?v=i4bvEKFWXAM **What is Financial Engineering**
2. **https://www.youtube.com/watch?v=Po7LBzcE8Kg Finance Primer for Engineers - Part 1**

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

1. Case studies.
2. Quizzes

Semester:	V	**Course Type:**	AEC		
Course Title:	**Marketing Management**				
Course Code:	23MEAE54			**Credits:**	01
Teaching Hours/Week (L:T:P:O)			0:2:0:0	**Total Hours:**	30
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	**Theory**			**Exam Hours:**	03

I. Course Objectives:

- Understanding of marketing management decisions.
- Understanding of marketing mix elements.
- Delivering Value and Building Customer Relationships
- Understanding Customer Needs and Wants

II. Teaching-Learning Process (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various courseoutcomes.

22. Expert talk
23. Practical Case study

III. COURSE CONTENT

Module 1

Understanding Marketing Management: Concepts of marketing, Role of Marketing,
Text book 1: Chapter 1

RBT Levels: L1,L2

Module 2

Marketing Process, Marketing Environment, consumer behavior, business buying behavior, analyzing competitors, qualities of Marketing manager.
Text book 1: Chapter 2

RBT Levels: L1,L2

Module3

Market segmentations and Marketing Strategies:-Market Segmentation, Target Market, differentiating and positioning,
Text book 1: Chapter 2

RBT Levels: L1,L2

Module 4

New Product Development, Product Life Cycle.
Text book 1: Chapter 3

RBT Levels: L1,L2

Module 5

Analysing Consumer Behaviour: Meaning and Characteristics, Importance of Consumer Behaviour, Factors Influencing Consumer Behaviour, Consumer Characteristics Influencing Buying Behaviour Personal Factors and Cultural Factors.
Text book 1: Chapter 2

IV. COURSE OUTCOMES

CO1	Comprehend the concepts of Marketing Management. L1
CO2	Gain knowledge on consumer behaviour and buying process L3

CO3	Understand concept of Product and Brand Management, Branding and Pricing strategies L2
CO4	Identify marketing channels and the concept of product distribution, techniques of sales promotion L4

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	2	1	1								2	1	1			
CO2	2	1	1								2	1	1			
CO3	2	1	1								2	1	1			
CO4	2	1	1								2	1	1			

VI. Assessment Details (CIE & SEE)

General Rules Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section – 4

Semester End Examination (SEE): Refer Annexure section - 4

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1.	Fundamentals of Marketing Management,	Etzel M J BJ Walker & William J Stanton	**November 2019**	Tata Macgraw Hill, Latest edition.

Reference Books

2.	Marketing Management, 16th Edition	P. Kotler	2022	Pearson Write a review

Web links and Video Lectures (e-Resources)

3. https://www.youtube.com/watch?v=E8HbqnrrXok&list=PLPjSqITyvDeUgSjU9XcEdZmd5Epz1L-Yn&index=5 **Evolution of Marketing**
4. https://www.youtube.com/watch?v=uZQHoQK4KFI&list=PLPjSqITyvDeUgSjU9XcEdZmd5Epz1L-Yn&index=11 **Competitive Analysis**
5. **https://www.youtube.com/watch?v=ZvcfAd30t0k&list=PLPjSqITyvDeUgSjU9XcEdZmd5Epz1L-Yn&index=20 Measurment and Scaling**

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. Case studies.
2. Quizzes

|| Jai Sri Gurudev ||
Sri Adichunchanagiri Shikshana Trust (R)
SJB Institute of Technology
BGS Health and Education City, Dr. Vishnuvardhana Road, Kengeri, Bengaluru-560060
Approved by AICTE, New Delhi.
Autonomous Institute affiliated to Visvesvaraya Technological University, Belagavi
Accredited by NAAC with 'A+'grade, Certified by ISO 9001 - 2015
Recognized by UGC, New Delhi with 2(f) & 12 (B)

Mechanical Engineering

6th Semester Syllabus

Semester:	VI	**Course Type:**	PCC		
Course Title: Machine Design					
Course Code:	**23MET601**			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3

I. Course Objectives:

- To explain the principles involved in design of machine elements, subjected to different kinds of forces, from the considerations of strength, rigidity.
- To understand and interpret different failure modes and application of appropriate criteria for design of machine elements.
- Develop the capability to design elements like shafts, couplings and welded joints, screwed joints.
- To learn transmission elements like gears, belts, pulleys, bearings from the manufacturers' catalogue.
- To produce assembly and working drawings of various mechanical systems involving
- Machine elements like clutches and brakes.

II. Teaching-Learning Process (General Instructions)

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

III. COURSE CONTENT

III(a). Theory PART

Module-1	8 Hrs

Introduction and Review: Review of engineering materials and their properties and manufacturing processes; use of codes and standards, selection of preferred sizes. Review of axial, bending, shear and torsion loading on machine components, combined loading.

Design for static strength: Factor of safety and service factor. Failure mode: definition and types., Failure of brittle and ductile materials; even and uneven materials; Stress concentration, stress concentration factor, Theories of failure: maximum normal stress theory, maximum shear stress theory, distortion energy theory, strain energy theory, Columba –Mohr theory and modified Mohr's theory

Impact Strength: Introduction, impact stresses due to axial, bending and torsion loads

Textbook: Chapter 1,2&3: sections 1.1 to 3.5	
Pre-requisites (Self Learning)students should be knowing the properties of different materials Solving the problems of machine components.	
RBT Levels: L1, L2	
Module-2	8 Hrs
Design of shafts: Torsion of shafts, solid and hollow shaft design with steady loading based on strength and rigidity, ASME and BIS codes for power transmission shafting, design of shafts subjected to combined bending, torsion and axial loading, Discussion on engineering applications. **Design of keys and couplings:** Keys: Types of keys and their applications, design considerations in parallel and tapered sunk keys, Design of square and rectangular sunk keys. Couplings: Rigid and flexible coupling types and applications, design of Flange coupling, and Bush and Pin type coupling.	
Textbook: Chapter 1,2&3: sections 1.1 to 3.5	
Pre-requisites (Self Learning)students should be knowing the properties of different materials Solving the problems of machine components.	
RBT Levels: L1, L2,L3	
Module-3	8 Hrs
Riveted joints: Types of rivets, rivet materials, Caulking and fullering, analysis of riveted joints, joint efficiency, failures of riveted joints, boiler joints, riveted brackets, Discussion on engineering applications. **Welded joints**: Types, strength of butt and fillet welds, eccentrically loaded welded joints, Discussion on engineering applications. Definitions, stresses in gear tooth: Lewis equation and form factor, design for strength, dynamic load and wear.	
Textbook: Chapter 4,5&6: sections 4.1 to 6.5	
Pre-requisites (Self Learning)students should be knowing the properties of different materials Solving the problems of joints.	
RBT Levels: L1, L2, L3	
Module-4	8 Hrs
Spur Gears: Definitions, stresses in gear tooth: Lewis equation and form factor, design for strength, dynamic load and wear **Bevel Gears**: Definitions, formative number of teeth, design based on strength, dynamic load and wear.	
Textbook: Chapter 7,8&9: sections 7.1 to 8.5	
Pre-requisites (Self Learning)students should be knowing the properties of different materials Solving the problems of gears.	
RBT Levels: L1, L2, L3	
Module-5	8 Hrs
Design of Clutches and Brakes: Design of single plate, multi-plate based on uniform pressure and uniform wear theories. Design of band brakes, block brakes **Lubrication and Bearings**: Lubricants and their properties, bearing materials and properties; mechanisms of lubrication, hydrodynamic lubrication, pressure development in oil film, bearing modulus, coefficient of friction, minimum oil film thickness, heat generated, and heat dissipated.	
Textbook: Chapter 10,11&12: sections 10.1 to 12.5	
Pre-requisites (Self Learning) students should be knowing the properties of different materials Solving the problems of engine components.	
RBT Levels: L1, L2,L3	
IV. COURSE OUTCOMES	
CO1	Apply codes and standards in the design of machine elements and select an element based on the Manufacturer's catalogue.

CO2	Analyse the performance and failure modes of mechanical components subjected to combined loading and impact loading using the concepts of theories of failure.
CO3	Demonstrate the application of engineering design tools to the design of machine components like shafts, keys, couplings, welded and riveted joints, brakes and clutches
CO4	Design different types of gears and simple gear boxes for relevant applications.
CO5	Apply design concepts of hydrodynamic bearings for different applications using the manufacturers, catalogue.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3	2											3			
CO2	3	2											3			
CO3	3	2											3			
CO4	3	2											3			
CO5	3	2											3			

VI. Assessment Details (CIE & SEE)

General Rules: Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section-1

Semester End Examination (SEE): Refer Annexure section-1

VII. Learning Resources

VII(a): Textbooks: (Insert or delete rows as per requirement)

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Mechanical Engineering Design	Richard G. Budynas, J. Keith Nisbett	2015 10th Edition	McGraw-Hill Education 10th Edition, 2015
2	Fundamentals of Machine Component Design	Juvinall R.C, and Marshek K.M John Wiley & Sons	2007 3rd Edition	Wiley student edition

VII(b): Reference Books: (Insert or delete rows as per requirement)

1	Design of Machine Elements	V. B. Bhandari Tata Mcgraw Hill	2006 4th Edition	McGraw-Hill Education
2	Machine Design	Robert Lnorton	2006 2nd Edition	Pearson education

VII(c): Web links and Video Lectures (e-Resources):

1. https://en.wikipedia.org/wiki/Machine_element
2. www.nptel.ac.in
3. https://cosmolearning.org
4. www.vtu.ac.in

http://nevonprojects.com/mini-projects-for-mechanical-engineering/

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

- Quizzes
- Assignments
- Seminars
- Case studies

Semester:	VI	**Course Type:**	IPCC		
Course Title:	**HEAT TRANSFER**				
Course Code:	23MEI602			**Credits:**	04
Teaching Hours/Week (L: T:P:O)			3:0:2:0	**Total Hours:**	40 + 12 Lab slots
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3

I. Course Objectives:

- Principles of heat transfer.
- Steady and transient heat transfer, obtain the differential equation of heat conduction in various coordinate systems.
- Physical mechanism of convection and visualize the development of velocity and thermal boundary layers during flow over a surface.
- Radiation heat transfer mechanism
- The mechanisms of boiling and condensation and understanding performance parameters of heat exchangers

II. Teaching-Learning Process (General Instructions):

These are sample Strategies that teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different teaching methods to develop the outcomes through presentations/ video demonstrations/ simulations.
- Chalk and talk method for problem-solving.
- Adopt collaborative learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.
- Conduct laboratory demonstrations and practical experiments to enhance experiential skills.

III. COURSE CONTENT

III(a). Theory PART

Module-1	8Hrs

Introduction: Review of basics of Modes of Heat Transfer. General form of one dimensional heat conduction equation. Boundary conditions of first, second and third kinds.

One dimensional Steady state conduction with and without heat generation: Steady state conduction in slab, cylinder and sphere with engineering applications.

Steady state conduction: Overall heat transfer coefficient for a composite medium; thermal contact resistance; critical thickness of insulation, Discussion on engineering applications.

Textbook: 1, Chapter 1 and 2, Page No. 1 to 73
Textbook: 2, Chapter 1 and 2, Page No. 1 to 176
Textbook: 3, Chapter1,2 &3, Page No. 1 to 217

Pre-requisites: Basic knowledge of fluids and their properties

RBT Levels: L1, L2, L3	
Module-2	8Hrs

Extended surfaces: Steady state conduction in fins of uniform cross section long fin, fin with insulated tip and fin with convection at the tip; fin efficiency & effectiveness, Discussion on engineering applications.

One dimensional Transient conduction: Conduction in solids with negligible internal temperature gradients (lumped system analysis) Use of transient temperature charts (Heisler's charts) for Transient conduction in slab, long cylinder and sphere; Discussion on engineering applications.

Textbook: 1, Chapter 2 and 3, Page No. 75 to 236
Textbook: 2, Chapter 4, Page No. 290 to 336
Textbook: 3, Chapter 3 and 4, Page No. 179 to 296

Pre-requisites: Basic knowledge of energy and conversion efficiencies

RBT Levels: L1, L2, L3

Module-3	8Hrs

Forced Convection: Physical significance of Dimensionless numbers. Use of various Correlations for hydro dynamically and thermally developed flows; Use of correlations for flow over a flat plate, cylinder, sphere and flow inside the duct.

Natural Convection: Physical significance of dimensionless numbers. Use of correlations for free convection from or to vertical, horizontal and inclined flat plates, vertical and inclined cylinder.

Textbook: 1, Chapter 4 and 5, Page No. 237 to 422
Textbook: 2, Chapter 7 and 8, Page No. 376 to 538
Textbook: 3, Chapter 7 and 8, Page No. 439 to 601

Pre-requisites: Basic knowledge of steam formation and properties of steam.

RBT Levels: L1, L2, L3

Module-4	8Hrs

Radiation Heat transfer: Review of basic laws of thermal radiation, Intensity of radiation and solid angle; Concept of thermal radiation resistance, Radiation network, view factor, Radiation heat exchange between two parallel infinite black surfaces, between two parallel infinite gray surfaces; Effect of radiation shield; Discussion on engineering applications

Textbook: 1, Chapter 7, Page No. 468 to 569
Textbook: 2, Chapter 11 and 12, Page No. 673 to 764
Textbook: 3, Chapter 12 and 13, Page No. 748 to 848

Pre-requisites: working principle of hydro turbines

RBT Levels: L1, L2, L3

Module-5	8Hrs

Boiling and Condensation: Pool boiling regimes. Basics of Film and dropwise condensation, Use of correlations for film and dropwise condensation on tubes.

Heat Exchangers: Classification of heat exchangers; Overall heat transfer coefficient, Fouling, Scaling factors; LMTD and NTU methods of analysis of heat exchangers.

Textbook: 1, Chapter 8, Page No. 570 to 641
Textbook: 2, Chapter 10, Page No. 574 to 669
Textbook: 3, Chapter 11, Page No. 677 to 726

Pre-requisites : working principle of pump and compressor

RBT Levels: L1, L2, L3

III(b). PRACTICAL PART

Sl. No.	Experiments
1	Determination of Thermal Conductivity of a Metal Rod.
2	Determination of Overall Heat Transfer Coefficient of a Composite wall.
3	Determination of Effectiveness on a Metallic fin.
4	Determination of Heat Transfer Coefficient in free Convection
5	Determination of Heat Transfer Coefficient in a Forced Convention
6	Determination of Emissivity of a Surface and Determination of Stefan Boltzmann Constant.
7	Determination of LMDT and Effectiveness in Parallel Flow Heat Exchangers
8	Determination of LMDT and Effectiveness in Counter Flow Heat Exchangers
9	Experiments on Boiling of Liquid and Condensation of Vapour
10	Experiment on Transient Conduction Heat Transfer

Instructions for conduction of practical part:

- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report

IV. COURSE OUTCOMES	
CO1	Determine temperature distribution in steady state heat conduction
CO2	Analyze the heat transfer through extended surfaces and transient heat conduction’
CO3	Analyze the forced and free convective heat transfer.
CO4	Analyze the radiation Heat transfer mechanism.
CO5	Design of heat exchangers using LMTD, NTU methods and analyse the boiling and condensation.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3	2											3			
CO2	3	2											3			
CO3	3	2											3			
CO4	3	2											3			
CO5	3	2	1										3			

VI. Assessment Details (CIE & SEE)

General Rules: Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section - 2

Semester End Examination (SEE): Refer Annexure section - 2

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Heat and Mass Transfer	P K Nag	2011	Tata Mc Graw Hill
2	Heat and Mass Transfer	R K Rajput	Sixth Edition 2015	S Chand publications
3	Heat transfer, a practical approach	Yunus A. Cengel	2020	Tata Mc Graw Hill

VII(b): Reference Books:

1	Heat Transfer Tata	Holman, J. P.	9th Edition 2008	McGraw Hill, New York
2	Principals of heat transfer	Frank Kreith, Raj M. Manglik, Mark S Bohn	Seventh Edition 2011.	Cengage learning

VII(c): Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=rxTK_SvSmvs&list=PL1gyM10tgL1hK9666oGndGlWDQdpQzkY9

https://www.kochheattransfer.com/products/twisted-tube-bundletechnology?gad=1&gclid=Cj0KCQjwmtGjBhDhARIsAEqfDEdG22TY7OHa8PBzHX1Yo_DKQcheV46aZxtD RvDIhCe1Gfpr5obDMLoaArSXEALw_wcB

https://www.hightempfurnaces.com/

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Activities like seminar, assignments, quiz, case studies, mini projects, industry visit, self-study activities, group discussions, etc

Semester:	VI	**Course Type:**	PCCL		
Course Title:	**DESIGN LABORATORY**				
Course Code:	**23MEL603**			**Credits:**	1
Teaching Hours/Week (L:T:P:O)			0:0:2:0	**Total Hours:**	14 Lab slots
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Practical			**Exam Hours:**	3

I. Course Objectives:

- To understand the concepts of natural frequency, logarithmic decrement, damping and damping ratio.
- To understand the techniques of balancing rotating masses and influence of gyroscopic couple.
- To verify the concept of the critical speed of a rotating shaft.
- To illustrate the concept of stress concentration using Photo elasticity.
- To appreciate the equilibrium speed, sensitiveness, power and effort of a Governor.
- To illustrate the principles of pressure development in an oil film of a hydrodynamic journal bearing.

II. Teaching-Learning Process (General Instructions):

Chalk and talk, Demonstration of model, videos etc

III. PRACTICAL PART

	Experiments
1	Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional)
2	Balancing of rotating masses
3	Determination of critical speed of a rotating shaft
4	Determination of equilibrium speed, sensitiveness, power and effort of Porter Governor.
5	Determination of Pressure distribution in Journal bearing
6	Determination of Fringe constant of Photo elastic material using. a) Circular disc subjected to diametral compression.
7	Determination of Fringe constant of Photo elastic material using. b) Pure bending specimen (four point bending).
8	Determine the stress concentration of circular disc with hole by photo elasticity
	Demonstration Experiments (For CIE)
9	Study the principle of working of a Gyroscope and demonstrate the Effect of gyroscopic Couple on plane disc

III. COURSE OUTCOMES

CO1	Compute the natural frequency of the free and forced vibration of single degree freedom systems, critical speed of shafts.
CO2	Carry out balancing of rotating masses and gyroscope phenomenon.
CO3	Analyse the governor characteristics.
CO4	Determine stresses in disk, beams and plates using photo elastic bench.
CO5	Determination of Pressure distribution in Journal bearing

IV. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/ PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3	2											2			

CO2	3	2											2			
CO3	3	2											2			
CO4	3	2											2			
CO5	3	2											2			

V. Assessment Details (CIE & SEE)

General Rules: Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section - 4

Semester End Examination (SEE): Refer Annexure section - 4

Semester:	VI	**Course Type:**	PEC		
Course Title:	**TOTAL QUALITY MANAGEMENT**				
Course Code:	23MEP621			**Credits:**	03
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

- Understand various approaches to TQM
- Understand the characteristics of quality leader and his role.
- Develop feedback and suggestion systems for quality management.
- Enhance the knowledge in Tools and Techniques of quality management

II. Teaching-Learning Process (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

III. COURSE CONTENT

III(a). Theory PART

Module-1: 8Hrs

Principles and Practice:
Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM.
Quality Management Systems: Introduction, benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements.
Text book 1: Chapter 1, 9

Pre-requisites (Self Learning): Basics of quality

RBT Levels: L1,L2

Module-2: 8Hrs

Leadership:
Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, Role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making,
Text book: Chapter 2

Pre-requisites (Self Learning): Leadership contents
Basics of planning and decision making

RBT Levels: L1,L2

Module-3: 8 Hrs

Customer Satisfaction and Customer Involvement:
Customer Satisfaction: customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, case studies.
Employee Involvement – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies.
Text book: Chapter 3,4

Pre-requisites (Self Learning)
Basics of how customer need changes

Case studies of employment involvement

RBT Levels: L1,L2

Module-4: 8 Hrs

Continuous Process Improvement:
The Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem solving methods, Kaizen, reengineering, six sigma, case studies.
Statistical Process Control: Pareto diagram, process flow diagram, cause and effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies.
Text book 1: Chapter 5,8

Pre-requisites (Self Learning): Visit to Toyota company
Basics of statistics

RBT Levels: L1,L2

Module-5: 8 Hrs

Total Productive Maintenance (TPM): Definition, Types of Maintenance, Steps in introduction of TPM in an organization, Pillars of TPM – 5S, Jishu Hozen, Quality Maintenance. Planned Maintenance.
Quality by Design (QbD): Definition, Key components of QbD, Role of QbD in Pharmaceutical Industry, Benefits and Challenges of QbD. Environmental Management Systems (EMS): Definition, Basic EMS, EMS under ISO 14001, Costs and Benefits of EMS
Text book 1: Chapter 8, 9 11

Pre-requisites (Self Learning)
Case studies of Japan based industry

RBT Levels: L1,L2

IV. COURSE OUTCOMES

CO1	Explain the various approaches of TQM
CO2	Infer the customer perception of quality
CO3	Analyses customer needs and perceptions to design feedback systems.
CO4	Apply statistical tools for continuous improvement of systems
C05	Apply the tools and technique for effective implementation of TQM.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3							1					1			
CO2	3							1					1			
CO3	3			3				1	1				1			
CO4	3				3								1			
CO5	3			3									1			

VI. Assessment Details (CIE & SEE)

General Rules: Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section – 1

Semester End Examination (SEE): Refer Annexure section – 1

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1.	Total Quality Management	Dale H. Besterfield	Edition 03. ISBN: 8129702606	Pearson Education India
2.	Operations Research	M. Zairi	ISBN:185573024	Wood head Publishing
3.	Managing for Quality and Performance Excellence	James R. Evans and William M Lindsay	9th edition	Cengage Learning

Reference Books				
1.	Four revolutions in management Shoji Shib	**Shoji Shiba, Alan Graham,**	2012	Oregon 1990
2.	Organizational Excellence through TQM	H. LaL		New age Publications
3.	Introduction to Operations Research Concepts and Cases	F.S. Hillier. G.J. Lieberman	9th Edition, 2010	Tata McGraw Hill
Web links and Video Lectures (e-Resources) https://nptel.ac.in/courses/112106134				
VIII: Activity Based Learning / Practical Based Learning/Experiential learning:				
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning Activities like seminar, assignments, quiz, case studies, group discussions, etc				

Semester:	**VI**	**Course Type:**	PEC		
Course Title:	**Mechanical Vibrations and Condition Monitoring**				
Course Code:	**23MEP622**			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3

I. Course Objectives:

- To introduce fundamental concepts of mechanical vibrations.
- To model and analyze degree-of-freedom of a systems.
- To understand vibration measurement and its instrumentation.
- To provide an introduction to vibration-based condition monitoring techniques.
- To correlate vibration signatures with machine faults for predictive maintenance.

II. Teaching-Learning Process (General Instructions):

- Chalk and talk method
- PowerPoint Presentation
- Case studies

III. COURSE CONTENT

III(a). Theory PART

Module 1: Introduction & Undamped (Single Degree of Freedom) Free Vibrations	8 Hrs

Types of vibrations, Definitions, Simple Harmonic Motion (S.H.M.), Work done by harmonic force, Principle of superposition applied to SHM, Beats, Fourier theorem and problems. Derivations for spring mass systems, Methods of Analysis, Natural frequencies of simple systems, Springs in series and parallel, Torsional and transverse vibrations, Effect of mass of spring and Problems.

Textbook 1: Chapter: sections: 1: 1,2

Pre-requisites: KOM & DOM

RBT Levels: L1, L2

Module 2: Damped free vibrations (1DOF)	8 Hrs

Types of damping, Analysis with viscous damping - Derivations for over-critical and under-damped systems, Logarithmic decrement and Problems.

Textbook 2: Chapter: 3

Pre-requisites : KOM & DOM

RBT Levels: L1, L2

Module-3: Forced Vibrations (1DOF)	8 Hrs

Introduction, Analysis of forced vibration with constant harmonic excitation - magnification factor, rotating and reciprocating unbalances, excitation of support (relative and absolute amplitudes), force and motion transmissibility, Energy dissipated due to damping and Problems. Vibrometers, Accelerometer, Frequency measuring instruments and Problems. Whirling of shafts with and without damping, discussion of speeds above and below critical speeds and Problems.

Textbook 1: Chapter: 4,8

Pre-requisites : KOM & DOM

RBT Levels: L3

Module 4: Modal analysis and Introduction to Condition Monitoring	8 Hrs

Signal analysis, dynamic testing of machines and structures, Experimental modal analysis, Need and benefits of condition monitoring, Vibration as a diagnostic tool Basic signal processing, Time and frequency domain analysis, FFT and spectrum analysis, Envelope detection

Textbook 2: Chapter: 4

Pre-requisites :KOM & DOM

RBT Levels: L3

Module-5: Vibration-Based Fault Diagnosisregards	8 Hrs
Common faults: imbalance, misalignment, looseness, bearing defects, Case studies: gearboxes, pumps, motors, Trending and predictive maintenance, Wireless vibration monitoring, AI/ML in predictive maintenance, ISO standards for vibration monitoring **Textbook 2: Chapter: 5**	
Pre-requisites ; KOM & DOM	
RBT Levels: L3	

IV. COURSE OUTCOMES

CO1	Explain fundamental concepts of mechanical vibrations and their applications in mechanical systems.
CO2	Develop and solve mathematical models for single degree-of-freedom damped systems under various excitation conditions.
CO3	Develop and solve mathematical models for single degree-of-freedom forced systems under various excitation conditions.
CO4	Perform basic vibration signal processing and fault diagnosis using time and frequency domain techniques.
CO5	Demonstrate the use of vibration-based condition monitoring for predictive maintenance of rotating machinery.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3	2	2										2			
CO2	3	2	2										2			
CO3	3	2	2										2			
CO4	3	2	2	3									2			
CO5	3	2	2	3	2								2			

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section-1

Continuous Internal Evaluation (CIE): Refer Annexure section-1

Semester End Examination (SEE): Refer Annexure section-1

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Mechanical Vibrations	G K Grover	8th Edition,	Nem Chand & Bros
2	Practical Machinery Vibration Analysis and Predictive Maintenance	Paresh Girdhar	Latest Edition.	IDC Technologies,

VII(b): Reference Books:

1	Mechanical Vibrations	William T. Thomson & Marie Dillon Dahleh	Latest Edition.	Wiley
2	Condition Monitoring with Vibration Signals	Hosameldin Ahmed & Asoke K. Nandi	Latest Edition.	McGraw-Hill,

VII(c): Web links and Video Lectures (e-Resources):

VTU e-Shikshana Program

VIII: Activity-Based Learning / Practical-Based Learning/Experiential learning:

- Quizzes
- Assignments
- Seminars

Semester:	VI	**Course Type:**	PEC		
Course Title:	**OPERATION RESEARCH**				
Course Code:	23MEP623			**Credits:**	03
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

- To introduce students to use quantitative methods and techniques for effective decisions– making;
- Mathematical model formulation and solving business decision problems.

II. Teaching-Learning Process (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

6. Use of Chalk and Talk method
7. Video lectures, lecture projections in class
8. Individual and Group assignments

III. COURSE CONTENT

III(a). Theory PART

Module-1: 8Hrs

Introduction: Evolution of OR, definition of OR, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, linear programming (LP) problem-formulation and solution by graphical method. The simplex method using slack variables.
Text book 1: Chapter 1- 1.1, 1.2, 1.3,1.4,1.5,1.6 Chapter 2- 2.1, 2.2, 2.3, 2.4, 2.5,2.6,2.7,2.8,2.9

RBT Levels: L1,L2,L3

Module-2: 8Hrs

Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using different methods, optimal solution by MODI method, degeneracy in transportation problems, application of transportation problem concept for maximization cases. **Assignment Problem:** Formulation, types, application to maximization cases and travelling salesman problem
Text book 1: Chapter 3- 3.1, 3.2, 3.3,3.4,3.5,3.6,3.7,3.8,3.9
Chapter 4- 4.1, 4.2, 4.3, 4.4, 4.5,4.6,4.7,4.8,4.9,4.10

RBT Levels: L1,L2,L3

Module-3: 8 Hrs

PERT-CPM Techniques: Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects
Text book 1:
Chapter 14- 14.1, 14.2, 14.3,14.4,14.5,14.6,14.7,14.8,14.9,14.10, ,14.22,14.23

RBT Levels: L1,L2,L3

Module-4: 8 Hrs

Game Theory: Formulation of games, types, solution of games with saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games.
Queuing Theory: Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), empirical queuing models (M/M/1 model).
Text book 2:
Chapter 9- 9.1,9.2,9.3
Chapter 12- 12.1,12.2,12.3,12.4,12.5

RBT Levels: L1,L2,L3

Module-5: 8 Hrs

Sequencing: Basic assumptions, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing 2 jobs on 'm' machines using graphical method.
Chapter 14-14.1,14.2,14.3,14.4

RBT Levels: L1,L2,L3

IV. COURSE OUTCOMES

CO1	Analyse the importance, phases, & limitations of operations research
CO2	Formulate a real-world problem in OR as a mathematical model.
CO3	Apply PERT and CPM network techniques to solve project management problems.
CO4	Choose appropriate OR models to solve transportation problem, assignment model, game theory, queuing theory and sequencing models

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3	3	3										2			
CO2	3	3	3										2			
CO3	3	3	3										2			
CO4	3	3	3										2			

VI. Assessment Details (CIE & SEE)

General Rules: Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section – 1

Semester End Examination (SEE): Refer Annexure section – 1

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1.	Operations Research	P K Gupta and D S Hira	2018	7th Edition, Chand Publications, New Delhi
2.	Operations Research	R. Panneerselvam	2023	3rd Edition, PHI
Reference Books				
2.	Operations Research Theory, Methods & Applications	S.D. Sharma	2012	Kedarnath Ramanath & Co
3.	Introduction to Operations Research	Hillier and Lieberman	1980	8th Edn, McGraw Hill

Web links and Video Lectures (e-Resources)
https://nptel.ac.in/courses/112106134

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning
Use appropriate software tools to solve real world problems Operations Research for different businesses

Semester:	VI	**Course Type:**	PEC		
Course Title:	**DESIGN FOR MANUFACTURING AND ASSEMBLY**				
Course Code:	23MEP624			**Credits:**	03
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

- To introduce students to use of various measurement methods and techniques for stress analysis
- Understand the formation of fringes and Coatings techniques for stress analysis in practical application

II. Teaching-Learning Process (General Instructions):

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

9. Use of Chalk and Talk method
10. Video lectures, lecture projections in class
11. Live demonstration of polariscope at Laboratory

III. COURSE CONTENT

III(a). Theory PART

Module-1: Major phases of design	8Hrs

Major phased of design, effect of material properties on design, effect of manufacturing Processes on design. Material selection process – cost per unit property, weighted properties and limits on properties methods. Guidelines for design for manufacturability.
Review of relationship between attainable tolerance grades and different machining processes. Process capability, mean, variance, skewness, kurtosis, process capability indices –Cp, and Cpk. Cumulative effect of tolerance – Sure fit law and truncated normal law, problems.
Text book 1: Chapter 1.1,1.2,1.4,1.6,1.7,1.8

RBT Levels: L1,L2

Module-2: Selective Assembly	8Hrs

Interchangeable part manufacture and selective assembly. Deciding the number of groups -model-1: group tolerance of mating parts equal, model- 2: total and group tolerances of shaft equal. Control of axial play- introducing secondary machining operations, and laminated shims; examples.**Text book 1**:
Chapter 2.1,2.2,3.3,3.4,3.5

RBT Levels: L1,L2

Module-3: Datum Features	8 Hrs

Datum Features: Functional datum, datum for manufacturing, changing the datum examples.
Component Design: Design features to facilitate machining: drills, milling cutters, keyways, Doweling procedures, counter sunk screws, Reduction of machined area, simplification by separation, simplification by amalgamation, Design for machinability, Design for economy, Design for clamp ability, Design for accessibility. Design for assembly
Text book 1:
Chapter 4.1, 4.2,4.3,4.4 6.1,6.2 ,6.3 ,6.11, 6.12 6.13

RBT Levels: L1,L2

Module-4: Design of components with casting considerations	8 Hrs

Pattern, Mould and parting line. Cored holes and machined holes. Identifying the possible and probable parting lines. Castings requiring special sand cores. Designing to obviates and cores.
Welding considerations: requirements and rules, redesign of components for welding; case studies

Text book 2:
Chapter 5.1,5.2,5.2,5.3,5.4

RBT Levels: L1,L2

Module-5: forging considerations and design for assembly	8 Hrs

Forging considerations -requirements and rules-redesign of components for forging and case studies. Design of components for powder metallurgy- requirements and rules-case studies. Design of components for injection moulding- requirements and rules-case studies.

Design for assembly

Design considerations for assembly, major guidelines for assembly improvement

Text book1: Chapter 6.1,6.2,6.3,6.4, 6.5 6.6, 6.7

RBT Levels: L1,L2

IV. COURSE OUTCOMES

CO1	Understand the phases of design process for manufacture and assembly
CO2	Apply concept of DFM for product design and assembly
CO3	Analyze components using design features to facilitate Manufacturing processes.
CO4	Apply the concept of DFM for casting, welding process
CO5	Understand the Forging, Moulding considerations

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3	1	2		1								1			
CO2	3	1	2		1								1			
CO3	3	1	2		1								1			
CO4	3	1	2		1								1			
CO5	3	1	2		1								1			

VI. Assessment Details (CIE & SEE)

General Rules: Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section – 1

Semester End Examination (SEE): Refer Annexure section – 1

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1.	Designing for Manufacture	Peck, H	1983	Pitman Publications, London
2.	Engineering Design: A Materials and processing Approach	Dieter, G.E	2000	McGraw Hill Co.Ltd.
Reference Books				
2.	Engineering Design	Eggert, R.J	2005	Pearson Education, Inc., New Jersey
3.	Engineering Design for Manufacture	Kalandar Saheb, S.D and Prabhakar, O	1999	ISPE

Web links and Video Lectures (e-Resources)

1. https://archive.nptel.ac.in/courses/107/103/107103012/

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Activities like seminar, assignments, quiz etc

Semester:	VI	**Course Type:**	OEC		
Course Title:	**PROJECT MANAGEMENT**				
Course Code:	**23MEO611**			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3

I. Course Objectives:

- To introduce fundamental concepts of the project management approach.
- To develop an understanding of project planning, scheduling, and execution.
- To explore risk management, quality control, and project cost estimation.
- To apply modern project management techniques for effective decision-making.

II. Teaching-Learning Process (General Instructions):

- Chalk and talk method
- PowerPoint Presentation
- Case studies

III. COURSE CONTENT

III(a). Theory PART

Module 1: Introduction to Project Management	8 Hrs

Definition and Characteristics of a Project, The Evolution of Project Management, Understanding Project Management, Organizational Structures and the Role of the Project Manager, Project Management Maturity Models, Classification of Projects, Project Life Cycles, Project Management Methodologies, Case Studies

Textbook: Chapter: sections: 1: 1,2,3

Pre-requisites: EME

RBT Levels: L1, L2

Module 2: Project Planning and Scheduling	8 Hrs

Project Scope Management and Work Breakdown Structure (WBS), Project Scheduling Techniques (Gantt Charts, Critical Path Method [CPM], and PERT), Resource Allocation and Cost Estimation, Project pricing & Cost Estimation

Textbook: Chapter: sections:1: 4, 11,12,13

Pre-requisites : EME

RBT Levels: L1, L2

Module-3: Risk and Quality Management in Projects	8 Hrs

Risk Management Framework and Risk Identification, Qualitative and Quantitative Risk Assessment, Risk Response Planning and Monitoring, Quality Planning, Assurance, and Control in Projects, Six Sigma, ISO Standards, and Quality Management

Textbook: Chapter: sections: 1: 17, 20

Pre-requisites : EME

RBT Levels: L1, L2, L3

Module 4: Project Execution, Monitoring, and Control	8 Hrs

Project supply chain management: - Plan purchasing and acquisitions, plan contracting, contract types, project partnering and collaborations, project supply chain management.

Project Progress and Results: Project Balanced Scorecard Approach, Internal project, customer, financial issues, Finishing the project: Terminate project early, finish projects on time, secure customer feedback and approval, knowledge management, perform administrative and contract closure.

Textbook: Chapter:sections: 2: 5

Pre-requisites :EME

RBT Levels: L1, L2, L3

Module-5: Advanced Topics and Modern Project Management Approaches	8 Hrs
Modern Project Management methodologies, The Project Management Maturity Model, Stakeholder Management and Effective Communication, Project Governance and Ethical Considerations, Emerging Trends in Project. **Textbook: Chapter: sections: 1: 21**	
Pre-requisites ; EME	
RBT Levels: L1, L2,L3	

IV. COURSE OUTCOMES

CO1	Understand the fundamental principles and framework of project management
CO2	Develop and analyse project plans, schedules, and cost estimates.
CO3	Apply risk management and quality control techniques in project execution.
CO4	Understand the activities like purchasing, acquisitions, contracting, partnering and elaborations related to performing projects.
CO5	Utilize modern project management tools and methodologies for effective decision-making

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3					2		2		2	3	1				
CO2	3					2		2		2	3	1				
CO3	3					2		2		2	3	1				
CO4	3					2		2		2	3	1				
CO5	3					2		2		2	3	1				

VI. Assessment Details (CIE & SEE)

General Rules: Academic Regulations

Continuous Internal Evaluation (CIE): Annexure section-1

Semester End Examination (SEE): Annexure section-1

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Project Management: A Systems Approach to Planning, Scheduling, and Controlling,	Harold Kerzner,	12th edition	Wiley,
2	Project Management	S Choudhury	2016	Mc Graw Hill Education (India) Pvt. Ltd. New Delhi,

VII(b): Reference Books: (Insert or delete rows as per requirement)

1	Project Management: A Managerial Approach	Jack R. Meredith, Samuel J. Mantel Jr.,	Latest Edition.	Wiley
2	Project Management: The Managerial Process,	Clifford F. Gray, Erik W. Larson	Latest Edition.	McGraw-Hill,

VII(c): Web links and Video Lectures (e-Resources):

VTU e-Shikshana Program

VIII: Activity-Based Learning / Practical-Based Learning/Experiential learning:

- Quizzes
- Assignments
- Seminars

Semester:	VI	**Course Type:**	OEC		
Course Title:	**Product Design and Development**				
Course Code:	**23MEO612**			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3

I. Course Objectives:

- To strike a balance between theory and practice through the emphasis on methods of product development.
- To learn set of product development methods that can be put into immediate practice on development projects
- To understand the perspectives of marketing, design, and manufacturing into a single approach to product development

II. Teaching-Learning Process (General Instructions):

- Chalk and talk method
- PowerPoint Presentation
- Videos

III. COURSE CONTENT

III(a). Theory PART

Module-1: Introduction — 8 Hrs

Introduction: Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development.
Development Processes and Organizations: A generic development process, concept development: the front-end process, adopting the generic product development process,
Textbook: 01, Chapter- 1
Ref Book: 01, Chapter- 2

RBT Levels: L1, L2

Module-2: Identifying Customer Needs and Concept Generation — 8 Hrs

Principles for the design of visual displays, Auditory displays, Design of controls, Combining displays and controls, Virtual ('synthetic') environments, Effectiveness, and cost-effectiveness.
Concept Generation: The activity of concept generation, clarify the problem, search externally, search internally, explore systematically, reflect on the results and the process.
Textbook: 01 Chapter: 6, 7

RBT Levels: L1, L2

Module-3: Concept Selection and Testing — 8 Hrs

Concept Selection: Overview of methodology, concept screening, and concept scoring,
Concept Testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process.
Textbook: 01 Chapter: 8, 9

RBT Levels: L1, L2

Module-4: Industrial Design — 8 Hrs

Industrial Design: Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, assessing the quality of industrial design.
Textbook: 01 Chapter: 11

RBT Levels: L1, L2

Module-5: Prototyping — 8 Hrs

Introduction to prototypes and its Types, Principles and Technologies & Case Studies
Textbook: 01 Chapter: 14

RBT Levels: L1, L2

IV. COURSE OUTCOMES

CO1	Describe the characteristics used for product design and development.
CO2	Assess the customer requirements in product design.
CO3	Apply structural approach to concept generation, selection and testing.
CO4	Identify various aspects of industrial design
CO5	Choose various principles and technologies used for the preparation of prototype.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3	2														
CO2	3	2														
CO3	3	2														
CO4	3	2														
CO5	3	2														

VI. Assessment Details (CIE & SEE)

General Rules: Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section-1

Semester End Examination (SEE): Refer Annexure section-1

VII. Learning Resources

VII(a): Textbooks: (Insert or delete rows as per requirement)

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Product Design and Development	Karl. T. Ulrich and Steven D Eppinger Irwin	5th Edition, 2011	McGraw- Hill

VII(b): Reference Books: (Insert or delete rows as per requirement)

1	Engineering Design	George E Deiter, Linda C. Schmidt	6th Edition, 2021	McGraw-Hill

VII(c): Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=6wuhwG6am1k&list=PLERed4ILxkJ0_NQuiMjOPGgBWscInDbWG
2. https://www.youtube.com/watch?v=ooR2HOASuvs&list=PLp6ek2hDcoNALWidcTcFur34atzXNYHjD

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

- Quizzes
- Assignments
- Seminars

Semester:	VI	**Course Type:**	OEC		
Course Title: **Energy Intelligence**					
Course Code:	23MEO613			**Credits:**	03
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

- To learn broader understandings on various aspects of solid waste management practiced in industries.
- To explore society's present needs and future energy demands.
- Gain knowledge of steam formation and properties of steam
- The petroleum import can be reused leading to increased economic growth

II. Teaching-Learning Process (General Instructions):

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
2. Show Videos/animation films to explain the content, wherever possible.
3. Ask HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking.
4. Discuss how every concept can be applied to the real world thus helping to improve the student's understanding.
5. Individual teachers can device innovative pedagogy to improve teaching-learning.

III. COURSE CONTENT

III(a). Theory PART

Module-1:	8Hrs

Introduction to Renewable Energy: Overview of global energy demand and the need for renewable energy, Environmental benefits and challenges of renewable energy. waste-to-energy technology as a renewable energy source. Role in advancing sustainable Waste management

Text book- 2, Chapter-2

Case study: status of waste generation in Bengaluru

RBT Levels: L1,L2,L3

Module-2:	8Hrs

Waste to Energy Conversion: Introduction, Classification of wastes. types of waste to energy, Thermal Analysis of various waste fuels, Overview of Power Generation, thermal treatment technologies used globally.

Waste Management: waste-to-energy as an integral part of sustainable waste management worldwide, and technologies used in different countries

Text book- 2, Chapter-2

RBT Levels: L1,L2,L3

Module-3:	8 Hrs

Fuels: Thermal properties of different wastes, like Bio-waste, Residual Waste, Medical Waste, Solid waste, and Electronic Waste source and its applications

Waste to energy technologies: plant layout, Bunker, Combustion chamber, Boiler, Steam turbine/generator, Air pollution control (APC), Stack

Activity based (find thermal properties of any one waste type)

Text book- 2 Chapter-3

RBT Levels: L1,L2,L3

Module-4:	8 Hrs
Boilers : Types, classifications of boilers, working of Fire Tube Boiler (Lancashire boiler) and Water Tube Boiler (Babcock & Wilcox), Boiler accessories and mountings: steam Separator, Air Preheater, Feed Pump, Injector, Soot Blower · Pressure-Reducing Valve, Superheater, Economizer **Modern steam turbines**: Working principal of Impulse and reaction, **Heat Exchanger**: Introduction, working of Radiator, condenser and evaporator Reference book-1 Chapter- 2, 3	
RBT Levels: L1,L2,L3	
Module-5:	8 Hrs
Energy plant: Control & Instrumentation, vibration analysis**,** Programming Logic Control (PLC), Digital Control System (DCS) **Energy Cost :** Analysis of Waste Collection Cost, Operation & Maintenance Cost, Investment Cost, Return on Investment. Per /KWh Generation Cost. Case study: any one waste to energy conversion plant visit Reference book-1 Chapter-2,3	
RBT Levels: L1,L2,L3	

IV. COURSE OUTCOMES

CO1	Analyse the need of renewable energy resources, historical and latest developments.
CO2	Apply the basics of solid waste management towards sustainable development.
CO3	Apply technologies to process waste to Energy conversion
CO4	Analyse thermal power plant working and control methods

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	-	-
CO1	2	2					1				1					
CO2	2	2					1				1					
CO3	2	2					1				1					
CO4	2	2					1				1					

VI. Assessment Details (CIE & SEE)

General Rules: Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section – 1

Semester End Examination (SEE): Refer Annexure section – 1

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1.	Waste-to-Energy Approaches Towards Zero Waste	Hussain, Chaudhery, PhD , Newark	2021	Elsevier
2.	Waste-to-Energy Technologies and Global Applications	Efstratios N. Kalogirou	2018	Taylor & Francis Group
Reference Books				
1.	Power Plant Engineering	Farshid Zabihian	2021	synergy Books India

Web links and Video Lectures (e-Resources)

- https://www.youtube.com/watch?v=uUmtJIBibMM How Trash Makes Money In The U.S.
- https://www.youtube.com/watch?v=JhxPMEyFW-Q Inside Massive Facility Burning Tons of Trash Everyday
- https://www.youtube.com/watch?v=94Qqzbz7hZE How To Turn Waste Into Electricity
- https://www.youtube.com/watch?v=FaC3FSN5P-I Municipal Waste to Energy and Power 24 MW Plant by Ramky Enviro Engineers
- https://www.youtube.com/watch?v=UAscjVNNF0Q Integrated Municipal Solid Waste Management Plant
- https://www.youtube.com/watch?v=zm0jslIE1kk How Gasification Turns Waste Into Energy
- https://www.youtube.com/watch?v=DYGQGygGwG8 Waste to Energy Plant Ghazipur

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

At the end of the lecture/presentation, assignments are to be given under each of the topics covered.
Case study: visiting plants

Semester:	VI	**Course Type:**	OEC		
Course Title:	**Electric and Hybrid Vehicle Technology**				
Course Code:	23MEO614			**Credits:**	03
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

- To understand the models, describe hybrid vehicles and their performance.
- To understand the different possible ways of energy storage.
- To understand the different strategies related to hybrid vehicle operation & energy management.

II. Teaching-Learning Process (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.

Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.

III. COURSE CONTENT

III(a). Theory PART

Module-1: 8Hrs

Introduction to Electric Vehicle (EV) & Hybrid Vehicle (HV):

A brief history of Electric and Hybrid vehicles, basic architecture of hybrid drive train, types of HV and EV, advantages over conventional vehicles, limitations of EV and HV, impact on environment of EV and HV technology, disposal of battery, cell and hazardous material and their impact on environment.

Textbook 1: Chapter 1

RBT Levels: L1,L2

Module-2: 8Hrs

Power Management and Energy Sources of EV and HV:

Power and Energy management strategies and its general architecture of EV and HV, various battery sources, energy storage, battery-based energy storage, Battery Management Systems (BMS), fuel cells, their characteristics, Super capacitor based energy storage, flywheel, hybridization of various energy storage devices, Selection of the energy storage technology.

Textbook 1: Chapter 2 & 3

RBT Levels: L1,L2,L3

Module-3: 8 Hrs

DC and AC Machines & Drives in EV & HV:

Various types of motors, selection and size of motors, **Induction** motor drives and control characteristics, **Permanent** magnet motor drives and characteristics, **Brushed & Brushless** DC motor drive and characteristics, **switched reluctance motors** and characteristics, mechanical and electrical connections of motors.

Textbook 1: Chapter 3

RBT Levels: L1,L2,L3

Module-4:	8 Hrs
Components & Design Considerations of EV & HV: Design parameters of batteries, ultra-capacitors and fuel cells, aerodynamic considerations, calculation of the rolling resistance and the grade resistance, calculation of the acceleration force, total tractive effort, torque required on the drive wheel, transmission efficiency, consideration of vehicle mass. **Textbook 1:** Chapter 2 & 4	
RBT Levels: L1,L2,L3	
Module-5:	8 Hrs
Electric and Hybrid Vehicles charging architecture: Introduction to smart charging: Grid to vehicle and vehicle to grid, smart metering and ancillary services, introduction to battery charging stations and its installation and commissioning, preliminary discussion on estimation on station capacity and associated technical issues, different connectors. **Textbook 1:** Chapter 5	
RBT Levels: L1,L2	

IV. COURSE OUTCOMES

CO1	Comprehend vehicle dynamics of electric and hybrid vehicles
CO2	Analyse the power management systems for electric and hybrid vehicles
CO3	Enumerate motor control strategies for electric and hybrid vehicles
CO4	Analyse various components of electric and hybrid vehicles with environment concern.
CO5	Estimate the domain related grid interconnections of electric and hybrid vehicle.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3						2									
CO2	3		2													
CO3	3															
CO4	3		2													
CO5	3						2									

VI. Assessment Details (CIE & SEE)

General Rules: Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section – 1

Semester End Examination (SEE): Refer Annexure section – 1

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1.	Electric and Hybrid Vehicles Design Fundamentals	Iqbal Hussain	2003	1st Edition, CRC Press
2.	Electric Vehicle Technology Explained	James Larminie, John Lowry	2003	1st Edition, John Wiley and Sons
Reference Books				
2.	Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives	Chris Mi, M. Abul Masrur, David Wenzhong Gao	2011	Wiley publication

3.	Hybrid Vehicles and the future of personal transportation	Allen Fuhs	2009	CRC Press
Website links https://nptel.ac.in/courses/108/103/108103009/ https://nptel.ac.in/courses/108/102/108102121/				
VIII : Activity Based Learning/Practical based learning/Experimental Learning				
Activity Based Learning (Suggested Activities in Class)Group discussion on Real world examples/presentation/Assignments				

Semester:	VI	**Course Type:**	ETC		
Course Title:	**Data Analytics with R**				
Course Code:	23MEE641			**Credits:**	03
Teaching Hours/Week (L:T:P:O)			2:0:2:@	**Total Hours:**	25 + 12 Lab slots
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

- To Gain the knowledge of R Programming concepts
- To Explain the concepts of Data Visualization
- To Explain the concepts of statistics in R.
- To Work with R charts and Graphs

II. Teaching-Learning Process (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various courseoutcomes.

12. Lecturer methods (L) need not to be only traditional lecture method, but alternative effectiveteaching methods could be adopted to attain the outcomes.
13. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop designthinking skills such as the ability to design, evaluate, generalize, and analyze information ratherthan simply recall it.
14. Introduce Topics in manifold representations.
15. Demonstrate ways to solve the same problem and encourage the students to come up with theirown creative solutions.
16. Discuss application of every concept to solve the real world problems.

III. COURSE CONTENT

III(a). Theory PART

Module-1:	5Hrs
Basics of R Introducing R, Initiating R, Packages in R, Environments and Functions, Flow Controls, Loops,Basic Data Types in R, Vectors Chapter 1: 1.1 to 1.7 Chapter 2: 2.1,2.2	
RBT Levels:L1,L2	
Module-2:	5Hrs
Basics of R Continued Matrices and Arrays, Lists, Data Frames, Factors, Strings, Dates and Times Chapter 2: 2.3,2.4,2.5,2.6,2.7.2.8.1,2.8.2	
RBT Levels: L1,L2	
Module-3:	5Hrs
Data Preparation Datasets, Importing and Exporting files, Accessing Databases, Data Cleaning and Transformation Chapter 3: 3.1,3.2,3.3,3.4	
RBT Levels: L1,L2,L3	
Module-4:	5 Hrs
Graphics using R Exploratory Data Analysis, Main Graphical Packages, Pie Charts, Scatter Plots, Line Plots,Histograms, Box Plots, Bar Plots, Other Graphical packages Chapter 4: 4.1 to 4.9	
RBT Levels: L1,L2	
Module-5:	5Hrs
Statistical Analysis using R	

Basic Statistical Measures, Normal distribution, Binomial distribution, Correlation Analysis, Regression Analysis-Linear Regression Analysis of Variance Chapter 5: 5.1, 5.3, 5.4, 5.5, 5.6.1, 5.7	
RBT Levels: L1,L2	
III(b). PRACTICAL PART	
Sl. No.	**Programs**
1	Demonstrate the steps for installation of R and R Studio. Perform the following: a) Assign different type of values to variables and display the type of variable. Assign different types such as Double, Integer, Logical, Complex and Character and understand the difference between each data type. b) Demonstrate Arithmetic and Logical Operations with simple examples. c) Demonstrate generation of sequences and creation of vectors. d) Demonstrate Creation of Matrices e) Demonstrate the Creation of Matrices from Vectors using Binding Function. f) Demonstrate element extraction from vectors, matrices and arrays
2	Assess the Financial Statement of an Organization being supplied with 2 vectors of data: Monthly Revenue and Monthly Expenses for the Financial Year. You can create your own sample data vector for this experiment) Calculate the following financial metrics: a. Profit for each month. b. Profit after tax for each month (Tax Rate is 30%). c. Profit margin for each month equals to profit after tax divided by revenue. d. Good Months – where the profit after tax was greater than the mean for the year. e. Bad Months – where the profit after tax was less than the mean for the year. f. The best month – where the profit after tax was max for the year. g. The worst month – where the profit after tax was min for the year. Note: a. All Results need to be presented as vectors b. Results for Dollar values need to be calculated with $0.01 precision, but need to be presented in Units of $1000 (i.e 1k) with no decimal points c. Results for the profit margin ratio need to be presented in units of % with no decimal point. d. It is okay for tax to be negative for any given month (deferred tax asset) e. Generate CSV file for the data.
3	Develop a program to create two 3 X 3 matrices A and B and perform the following operations a) Transpose of the matrix b) addition c) subtraction d) multiplication
4	The built-in data set mammals contain data on body weight versus brain weight. Develop R commands to: a) Find the Pearson and Spearman correlation coefficients. Are they similar? b) Plot the data using the plot command. c) Plot the logarithm (log) of each variable and see if that makes a difference..
5	Develop a program to find the factorial of given number using recursive function calls.
6	Let us use the built-in dataset air quality which has Daily air quality measurements in New York, May to September 1973. Develop R program to generate histogram by using appropriate arguments for the following statements. a) Assigning names, using the air quality data set. b) Change colors of the Histogram c) Remove Axis and Add labels to Histogram

	d) Change Axis limits of a Histogram e) Add Density curve to the histogram
7	Using the built in dataset mtcars which is a popular dataset consisting of the design and fuel consumption patterns of 32 different automobiles. The data was extracted from the 1974 Motor Trend US magazine, and comprises fuel consumption and 10 aspects of automobile design and performance for 32 automobiles (1973-74 models). Format A data frame with 32 observations on 11 variables : [1] mpg Miles/(US) gallon, [2] cyl Number of cylinders [3] disp Displacement (cu.in.), [4] hp Gross horsepower [5] drat Rear axle ratio,[6] wt Weight (lb/1000) [7] qsec 1/4 mile time, [8] vs V/S, [9] am Transmission (0 = automatic, 1 = manual), [10] gear Number of forward gears, [11] carb Number of carburetors Develop R program, to solve the following: a) What is the total number of observations and variables in the dataset? b) Find the car with the largest hp and the least hp using suitable functions c) Plot histogram / density for each variable and determine whether continuous variables are normally distributed or not. If not, what is their skewness? d) What is the average difference of gross horse power(hp) between automobiles with 3 and 4 number of cylinders(cyl)? Also determine the difference in their standard deviations. e) Which pair of variables has the highest Pearson correlation?

IV. COURSE OUTCOMES

CO1	Describe the structures of R Programming
CO2	Illustrate the basics of Data Preparation with real world examples.
CO3	Apply the Graphical Packages of R for visualization.
CO4	Apply various Statistical Analysis methods for data analytics.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3	3			3									2		
CO2	3	3			3									2		
CO3	3	3			3									2		
CO4	3	3			3									2		

VI. Assessment Details (CIE & SEE)

General Rules: Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section – 2

Semester End Examination (SEE): Refer Annexure section – 2

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1.	R Programming: An Approach to Data Analytics	G. Sudhamathy and C. Jothi Venkateswaran	2019	MJP Publishers
Reference Books				
2.	Learning R A Step by Step Function Guide to Data Analysis	Cotton, R.	2013	1st ed. O'Reilly Media Inc
3.	Principles of Artificial Intelligence	Nils J. Nilsson	1980	Elsevier

4.	Artificial Intelligence	Saroj Kaushik	2014	Cengage learning

Web links and Video Lectures (e-Resources)

1. URL: https://cran.r-project.org/doc/manuals/r-release/R-intro.pdf
2. http://www.tutorialspoint.com/r/r_tutorial.pdf
3. https://users.phhp.ufl.edu/rlp176/Courses/PHC6089/R_notes/intro.html
4. https://cran.r-project.org/web/packages/explore/vignettes/explore_mtcars.html
5. https://www.w3schools.com/r/r_stat_data_set.asp
6. https://rpubs.com/BillB/217355

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. Group discussion on Real world examples
2. Project based learning

Semester:	VI	**Course Type:**	ETC		
Course Title:	**ADVANCE PRODUCTION SYSTEM**				
Course Code:	23MEP642			**Credits:**	03
Teaching Hours/Week (L:T:P:O)			3:0:0:@	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

- Eliminate waste that is, minimise the amount of equipment, materials, parts, space, and worker's time, which adds a great value to the product
- Increase productivity.
- To produce and deliver what is needed, when it is needed, at all stages of the production process.

II. Teaching-Learning Process (General Instructions):

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

17. Lecturer method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
18. Show Videos/animation films to explain the content, wherever possible.
19. Ask HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking.
20. Discuss how every concept can be applied to the real world thus helping to improve the student's understanding.
21. Individual teachers can device innovative pedagogy to improve teaching-learning.

III. COURSE CONTENT

III(a). Theory PART

Module-1: 8Hrs

INTRODUCTION: Speed of JIT movement, the new production system research association of Japan, some definitions of JIT, core Japanese practices of JIT, enabling JIT to occur, basic element of JIT, benefits of JIT.

MODERN PRODUCTION SYSTEM: Key feature of Toyota's production system, basic framework of Toyota production system.

KANBAN SYSTEM other types of kanban's, kanban rules, determining the number of kanban's in Toyota production system.

Text book- 1 Chapter- 1

RBT Levels: L1,L2,L3

Module-2: 8Hrs

PRODUCTION SMOOTHING IN TOYOTA PRODUCTION SYSTEM: production planning, production smoothing, adaptability to demand fluctuations, sequencing method for the mixed model assembly line to realize smoothed production. EDP system for support of the Toyota Production system.

GLOBAL IMPLEMENTATION OF JIT: JIT in automotive industry, JIT in electronics, computer, telecommunication and instrumentation, JIT in process type industry, JIT in seasonal demand industry, other manufacturing industries, conclusion.

Text book- 1 Chapter- 3

RBT Levels: L1,L2,L3

Module-3: 8 Hrs

JIT IMPLEMENTATION SURVEYS: JIT implementation in US manufacturing firms-analysis of survey results, just in time manufacturing industries, just in time production in West Germany, just in time production in Hong Kong electronics indu8stry, conclusion.

DESIGN, DEVELOPMENT AND MANAGEMENT OF JIT MANUFACTURING SYSTEMS: plant configurations and flow analysis for JIT manufacturing, comparison of JIT's "demand pull" system with conventional "push type" planning and control systems, quality management system for JIT, product design for JIT human resource management in JIT, flexible workforce system at Toyota.

Text book- 1 Chapter- 3

RBT Levels: L1,L2,L3

Module-4: 8 Hrs

SUPPLY MANAGEMENT FOR JIT: JIT purchasing-the Japanese way, some studies in JIT purchasing, experience of implementation organizations, surveys of JIT purchasing, buyer-seller relationship in JIT purchasing, Quality certification of suppliers in JIT purchasing, some problems in implementation of JIT purchasing, reduction freight costs in JIT purchasing, monitoring supplier performance for JIT purchasing, audit in JIT purchasing, implementation of JIT to international sourcing.

Text book- 2 Chapter- 9

RBT Levels: L1,L2,L3

Module-5: 8 Hrs

FRAMEWORK FOR IMPLEMENTATION OF JIT: Implementation risk, risks Due to inappropriate understanding of JIT, risks due to technical, operational and people problems, risks associated with kanban system, some important activities to be performed during implementation, steps in implementation, a project work to approach to implementation, conclusion.

Text book- 1 Chapter- 10

RBT Levels: L1,L2,L3

IV. COURSE OUTCOMES

CO1	Produce an overview on lean / just-in-time and repetitive manufacturing.
CO2	Explain the lean / just-in-time concept in detail.
CO3	Describe the Kanban technique
CO4	Identify to implementing procedure and a comparison of techniques.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	2	2	1										1			
CO2	2	2	1										1			
CO3	2	2	1										1			
CO4	2	2	1										1			

VI. Assessment Details (CIE & SEE)

General Rules: Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section – 1

Semester End Examination (SEE): Refer Annexure section – 1

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1.	Toyota Production System	Yasuhiro Monden	2011/ ISBN-10 : 143982097X	Productivity Press
2.	Advanced Operations/Production Management:	Tapan Kumar Roy	2017	Independently Published

Reference Books				
1.	Toyota Production System: Beyond Large-Scale Production	Taiichi Ohno	ISBN-9780915299140	Productivity Press;

Web links and Video Lectures (e-Resources)

- https://youtu.be/zCTmN17ZDek
- https://youtu.be/cAUXHJBB5CM
- https://youtu.be/6y3qrOla9Tc
- https://youtu.be/OXVi7dOF3jU
- https://youtu.be/9onMrDbDKaM
- https://study.com/academy/lesson/jit-lean-implementation-uses-drawbacks.html
- https://www.investopedia.com/terms/j/jit.asp
- https://youtu.be/9OL7BMBa4ys

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

At the end of the lecture/presentation, assignments are to be given under each of the topics covered.

Semester:	VI	**Course Type:**	ETC		
Course Title: **Product Design and Development**					
Course Code:	**23MEE643**			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3

I. Course Objectives:

- To strike a balance between theory and practice through the emphasis on methods of product development.
- To learn set of product development methods that can be put into immediate practice on development projects
- To understand the perspectives of marketing, design, and manufacturing into a single approach to product development

II. Teaching-Learning Process (General Instructions):

- Chalk and talk method
- PowerPoint Presentation
- Videos

III. COURSE CONTENT

III(a). Theory PART

Module-1: Introduction	8 Hrs

Introduction: Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development.
Development Processes and Organizations: A generic development process, concept development: the front-end process, adopting the generic product development process,
Textbook: 01, Chapter- 1
Ref Book: 01, Chapter- 2

Pre-requisites – Engineering Drawing

RBT Levels: L1, L2

Module-2: Identifying Customer Needs and Concept Generation	8 Hrs

Principles for the design of visual displays, Auditory displays, Design of controls, Combining displays and controls, Virtual ('synthetic') environments, Effectiveness, and cost-effectiveness.
Concept Generation: The activity of concept generation, clarify the problem, search externally, search internally, explore systematically, reflect on the results and the process.
Textbook: 01 Chapter: 6, 7

Pre-requisites - Engineering Drawing

RBT Levels: L1, L2

Module-3: Concept Selection and Testing	8 Hrs

Concept Selection: Overview of methodology, concept screening, and concept scoring,
Concept Testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process.
Textbook: 01 Chapter: 8, 9

Pre-requisites (Self Learning): Engineering Drawing

RBT Levels: L1, L2

Module-4: Industrial Design	8 Hrs

Industrial Design: Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, assessing the quality of industrial design.
Textbook: 01 Chapter: 11

Pre-requisites (Self Learning): Engineering Drawing

RBT Levels: L1, L2

Module-5: Prototyping	8 Hrs

Introduction to prototypes and its Types, Principles and Technologies & Case Studies

Textbook: 01 Chapter: 14

Pre-requisites (Self Learning): Engineering Drawing

RBT Levels: L1, L2

IV. COURSE OUTCOMES

CO1	Describe the characteristics used for product design and development.
CO2	Assess the customer requirements in product design.
CO3	Apply structural approach to concept generation, selection and testing.
CO4	Identify various aspects of industrial design
CO5	Choose various principles and technologies used for the preparation of prototype.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3	2											1			
CO2	3	2											1			
CO3	3	2											1			
CO4	3	2											1			
CO5	3	2											1			

VI. Assessment Details (CIE & SEE)

General Rules: Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section – 1

Semester End Examination (SEE): Refer Annexure section – 1

VII. Learning Resources

VII(a): Textbooks: (Insert or delete rows as per requirement)

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Product Design and Development	Karl. T. Ulrich and Steven D Eppinger Irwin	5th Edition, 2011	McGraw- Hill

VII(b): Reference Books: (Insert or delete rows as per requirement)

1	Engineering Design	George E Deiter, Linda C. Schmidt	6th Edition, 2021	McGraw-Hill

VII(c): Web links and Video Lectures (e-Resources):

https://youtu.be/HN9GtL21rb4?si=h5pJnS3tHDHv4xWy
https://youtu.be/qgVs8vskWl0?si=OanOrFlq_EIR0YNv
https://youtu.be/CkezCE3GmeQ?si=OinG6yRH62h7ZK8Z
https://youtu.be/Mj9IGfINV1A?si=W0njJaBu0Um3zFuX

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

- Quizzes
- Assignments
- Seminars

Semester:	VI	**Course Type:**	ETC		
Course Title: Automobile Engineering					
Course Code:	23MEE644			**Credits:**	03
Teaching Hours/Week (L:T:P:O)			2:0:2:@	**Total Hours:**	25+12 Lab slots
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

At the end of this course, students will be able to:

- Explain the components of IC engine and their classifications.
- Interpret the combustion process in SI and CI engines.
- Analyze IC engine emissions, effects and their control methods.
- Examine various types of alternative fuels for IC engines and understand the working of EV vehicles

II. Teaching-Learning Process (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

22. Lecturer methods (L) need not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
23. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information ratherthan simply recall it.
24. Introduce Topics in manifold representations.
25. Demonstrate ways to solve the same problem and encourage the students to come up with theirown creative solutions.

III. COURSE CONTENT

III(a). Theory PART

Module-1: 5Hrs

Introduction: Heat engine, engine components and basic nomenclature, IC Engine classification, comparison of four stroke and two stroke cycle engines, comparison of SI and CI engine, valve timing and port timing diagram, applications of IC engines.

Textbook 1: Chapter 1, Page No. 1 to 42

Textbook 2: Chapter 1, Page No. 1 to 42

RBT Levels: L1, L2, L3

Module-2: 5Hrs

Combustion in SI Engine: Ignition limits, stages of combustion in SI engine, concept of combustion quality, effect of engine variables on ignition lag and flame propagation, rate of pressure rise, abnormal combustion, detonation or knocking, effects of detonation, effect of engine variables on knock or detonation.

Textbook 1: Chapter 5, Page No. 164 to 213

RBT Levels: L1, L2, L3

Module-3: 5Hrs

Combustion in CI Engine: stages of combustion in CI engine, Air fuel ratio on CI Engine, Delay period of Ignition lag, Variables affecting delay period, Diesel knock.

Engine cooling: Necessity of engine cooling, Thermo-syphon cooling, thermostat cooling and evaporative cooling.

Textbook 1: Chapter 6, Page No. 214 to 249 and Chapter 15 Page No. 519 to 555

RBT Levels: L1,L2,L3

Module-4: 5 Hrs

Engine emissions and their control: air pollution due to IC engines, emission norms, unburnt hydrocarbons, oxides of carbon, oxides of nitrogen, oxides of sulphur and particulates emissions formation

and effects. Emission control methods thermal converters, catalytic converters, particulate traps and exhaust gas recirculation.

Textbook 2: Chapter 14 Page No. 417 to 453

RBT Levels: L1, L2, L3

Module-5:	5Hrs

Alternative fuels: Methanol, Ethanol, Biodiesel, Hydrogen LPG, CNG and Biogas properties, advantages and disadvantages of fuels.

Electric vehicle: working principle, benefits compare to IC engine, advantages and challenges in electric vehicles.

Textbook 2: Chapter 6 Page No. 163 to 187

RBT Levels: L1, L2, L3

PRACTICAL COMPONENTS

Sl. No.	**EXPERIMENTS**
1	Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Marten's (closed) / Cleveland's (Open Cup) Apparatus.
2	Determination of Calorific value of solid, liquid and gaseous fuels.
3	Valve Timing/port opening diagram of an I.C. Engine.
4	Performance Tests on Two stroke Petrol Engine
5	Performance Tests on Four stroke Petrol Engine
6	Performance Tests on Four stroke Diesel Engine
7	Multi Cylinder Diesel/Petrol Engine, (Morse test)
8	Performance Tests on Variable Compression Ratio I.C. Engine

IV. COURSE OUTCOMES

CO1	Interpret different parts of an automobile and it's working.
CO2	Analysis of combustion process in SI and CI Engine
CO3	Analyse the cause of automobile emissions, its effects on environment and methods to reduce the emissions.
CO4	Elaborate alternate fuels for IC engines and EV vehicle functioning.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	--	--
CO1	3	2											3			
CO2	3	2											3			
CO3	3	2					1						3			
CO4	3	2											3			

VI. Assessment Details (CIE & SEE)

General Rules: Academic Regulations

Continuous Internal Evaluation (CIE): Refer Annexure section – 2

Semester End Examination (SEE): Refer Annexure section – 2

VII. Learning Resources

VII(a): Textbooks:

Sl. No.	**Title of the Book**	**Name of the author**	**Edition and Year**	**Name of the publisher**
1.	Internal combustion engine	M L Mathur and R P Sharma	20th print, 2009	Dhanpat rai Publications
2.	Internal combustion engine	V Ganesan	4th edition, 2012	Tata McGraw Hill

Reference Books

1	Automobile engineering Vol I and II	Kirpal Singh	12th Edition 2011	Standard Publishers
2	Fundamentals of Automobile Engineering	K.K. Ramalingam	---	Scitech Publications (India) Pvt. Ltd

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=8dAbcbAJRw8
https://www.youtube.com/watch?v=ZSkB3zrU8T4
https://www.youtube.com/watch?v=80x4IAm1n6o
https://www.youtube.com/watch?v=tJfERzrG-D8

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

3. Group discussion on Real world examples
4. Project based learning

Semester:	VI	**Course Type:**	AEC		
Course Title: Research Methodology & IPR					
Course Code:	**23RMAE61**		**Credits:**		03
Teaching Hours/Week (L:T:P:O)			3:0:0:@	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

- To Understand the knowledge on basics of research and its types.
- To Learn the concept of Literature Review, Technical Reading, Attributions and Citations.
- To learn Ethics in Engineering Research.
- To Discuss the concepts of Intellectual Property Rights in engineering.

II. Teaching-Learning Process :

- Chalk and talk method
- Power point presentation / keynotes
- Videos

III. COURSE CONTENT

III(a). Theory PART

Module-1: Introduction 08Hrs

Introduction: Meaning of Research, Objectives of Engineering Research, and Motivation in Engineering Research, Types of Engineering Research, Finding and Solving a Worthwhile Problem.

Ethics in Engineering Research, Ethics in Engineering Research Practice, Types of Research Misconduct, Ethical Issues Related to Authorship.

Textbook 1 : Chapter1 : sections: 1.1,1.2,1.3,1.4
Textbook 1 : Chapter5 : sections: 5.1,5.2,5.3

Self Learning : Case Studies

RBT Levels: L2

Module-2: Literature Review and Technical Reading 08Hrs

Literature Review and Technical Reading, New and Existing Knowledge, Analysis and Synthesis of Prior Art Bibliographic Databases, Web of Science, Google and Google Scholar, Effective Search: The Way Forward Introduction to Technical Reading Conceptualizing Research, Critical and Creative Reading, Taking Notes While Reading, Reading Mathematics and Algorithms, Reading a Datasheet.

Attributions and Citations: Giving Credit Wherever Due, Citations: Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge Flow through Citation, Citing Datasets, Styles for Citations, Acknowledgments and Attributions, What Should Be Acknowledged, Acknowledgments in, Books Dissertations, Dedication or Acknowledgments.

Textbook1: Chapter2: sections: 2.1,2.2,2.3,2.4,2.5,2.6,2.7,2.8,2.9,2.10
Textbook1: Chapter3: sections: 3.1,3.2,3.3,3.4

Self Learning : Case Studies

RBT Levels: L2	
Module-3: Introduction To Intellectual Property	08Hrs

Introduction To Intellectual Property: Role of IP in the Economic and Cultural Development of the Society, IP Governance, IP as a Global Indicator of Innovation, Origin of IP History of IP in India. Major Amendments in IP Laws and Acts in India.

Patents: Conditions for Obtaining a Patent Protection, To Patent or Not to Patent an Invention. Rights Associated with Patents. Enforcement of Patent Rights. Inventions Eligible for Patenting. Non-Patentable Matters. Patent Infringements. Avoid Public Disclosure of an Invention before Patenting.

Process of Patenting. Prior Art Search. Choice of Application to be Filed. Patent Application Forms. Jurisdiction of Filing Patent Application. Publication. Pre-grant Opposition. Examination. Grant of a Patent. Validity of Patent Protection. Post-grant Opposition.

Textbook2: Chapter1: sections:1.1,1.2,1.3,1.4,1.6
Textbook2: Chapter2: sections:2.1 (2.1.1 to 2.1.9)

Self Learning : Case Studies

RBT Levels: L2

Module-4: Copyrights and Related Rights	08 Hrs

Copyrights and Related Rights: Classes of Copyrights. Criteria for Copyright. Ownership of Copyright. Copyrights of the Author. Copyright Infringements. Copyright Infringement is a Criminal Offence. Copyright Infringement is a Cognizable Offence. Fair Use Doctrine. Copyrights and Internet. Non-Copyright Work. Copyright Registration. Judicial Powers of the Registrar of Copyrights. Fee Structure. Copyright Symbol. Validity of Copyright. Copyright Profile of India. Copyright and the word 'Publish'. Transfer of Copyrights to a Publisher. Copyrights and the Word 'Adaptation'. Copyrights and the Word 'Indian Work'. Joint Authorship. Copyright Society. Copyright Board. Copyright Enforcement Advisory Council (CEAC). International Copyright Agreements, Conventions and Treaties. Interesting Copyrights Cases.

Trademarks: Eligibility Criteria. Who Can Apply for a Trademark. Acts and Laws. Designation of Trademark Symbols. Classification of Trademarks. Registration of a Trademark is Not Compulsory. Validity of Trademark. Types of Trademark Registered in India. Trademark Registry. Process for Trademarks Registration. Prior Art Search. Famous Case Law: Coca-Cola Company vs. Bisleri International Pvt. Ltd.

Textbook2: Chapter2: sections: 2.2 (except 2.2.6)
Textbook2: Chapter2: sections:2.3 (2.3.1 to 2.3.10, 2.3.14)

Learning : Case Studies

RBT Levels: L2

Module-5: Industrial Designs	08Hrs

Industrial Designs: Eligibility Criteria. Acts and Laws to Govern Industrial Designs. Design Rights. Enforcement of Design Rights. Non-Protectable Industrial Designs India. Protection Term. Procedure for Registration of Industrial Designs. Prior Art Search. Application for Registration. Duration of the Registration of a Design. Importance of Design Registration. Cancellation of the Registered Design. Application Forms. Classification of Industrial Designs. Designs Registration Trend in India. International Treaties. Famous Case Law: Apple Inc. vs. Samsung Electronics Co.

Geographical Indications: Acts, Laws and Rules Pertaining to GI. Ownership of GI. Rights Granted to the Holders. Registered GI in India. Identification of Registered GI. Classes of GI. Non-Registerable GI. Protection of GI. Collective or Certification Marks. Enforcement of GI Rights. Procedure for GI Registration Documents Required for GI Registration. GI Ecosystem in India.

Textbook2: Chapter2: Sections : 2.4, 2.5 (2.5.1 – 2.5.13)

Self Learning : Case Studies

RBT Levels:L2

IV. COURSE OUTCOMES

CO1	Understand the importance of engineering research and its ethics.
CO2	Interpret the fundaments of Literature Review and Technical Reading.
CO3	Outline the fundamentals of patens laws and drafting procedure.
CO4	Illustrate the copyright laws and basic principles of design rights.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	2							2		1		2				
CO2	2							3		3		2				
CO3				2				3	2	2		3				
CO4								3	2	2		3				

VI. Assessment Details (CIE & SEE)

General Rules: Refer to – Academic regulations

Continuous Internal Evaluation (CIE): Refer to Annexure, SL #5
Rubrics: Refer to Annexure, SL #5

Semester End Examination (SEE): Refer to - Annexure, SL #5
Rubrics: Refer to - Annexure, SL #5

I. Learning Resources

VII(a): Textbooks:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Engineering Research Methodology	Dipankar Deb, Rajeeb Dey, Valentina E. Balas	ISSN 1868- 4394 ISSN 1868-4408 (electronic)	Intelligent Systems Reference Library, ISBN 978-981-13-2946-3 ISBN 978-981-13-2947-0 (eBook),

2	Intellectual Property A Primer for Academia	Prof. Rupinder Tewari Ms. Mamta Bhardwaj	2021	Publication Bureau, Panjab University Chandigarh-160014, India
VII(b): Reference Books:				
1	Research Methods for Engineers	David V. Thiel	978-1-107-03488-4	Cambridge University Press
2	Intellectual Property Rights	N.K.Acharya	ISBN: 978-93-81849-30-9	Asia Law House 6th Edition
VII(c): Web links and Video Lectures (e-Resources):				
https://www.youtube.com/watch?v=5fvpsqPWZac http://kcl.digimat.in/nptel/courses/video/109106137/L68.html http://kcl.digimat.in/nptel/courses/video/109106137/L72.html http://acl.digimat.in/nptel/courses/video/109106137/L04.html				
VIII: Activity Based Learning / Practical Based Learning/Experiential learning:				
Quizzes, Assignments, Seminars				

Semester:	VI	**Course Type:**	HSMC		
Course Title:	**Social Connect Responsibility**				
Course Code:	**23SCRH08**			**Credits:**	01
Teaching Hours/Week (L: T: P: O)		1:0:0:0		**Total Hours:**	15
CIE Marks:	50			**Total Marks:**	50

I. Course Objectives:

- This course aims to familiarize students with the dynamics of society and importance of conscious participation in the formation of an ideal society
- The course enables students to critically analyze the social processes of globalization, modernization and social change, and its impact on the socio-cultural system.
- The course aims to develop socially responsible engineers by engaging them in real-world social issues, analyzing their impact, proposing innovative solutions, and effectively documenting their findings.
- The course enables students to create a responsible connection with the society.

II. Teaching-Learning Process (General Instructions):

This course is designed to provide students with hands-on learning experiences that foster social awareness, critical thinking, and problem-solving skills. Teachers play a crucial role in guiding students through real-world issues and encouraging innovative, ethical solutions.

1. Foster an Experiential Learning Approach
   - Encourage field visits, case studies, and real-world problem analysis rather than relying solely on theoretical lectures.
   - Use problem-based learning (PBL) where students actively engage with a community issue and work towards solving it.
2. Facilitate Active Student Engagement
   - Conduct brainstorming sessions to help students identify and understand societal problems.
   - Promote group discussions and debates on contemporary social issues.
3. Encourage Innovative & Feasible Solutions
   - Help students explore technology-driven solutions using engineering principles.
   - Promote a multi-disciplinary approach, integrating environmental, social, and economic aspects.
4. Promote Community Interaction & Implementation
   - Guide students to collaborate with NGOs, local communities, or government agencies.
   - Ensure that students test their solutions in real-world settings and collect feedback.
   - Emphasize the importance of ethical considerations in community engagement.
5. Train Students in Documentation & Reporting
   - Teach students how to prepare structured reports on their findings, solutions, and implementation outcomes.
   - Encourage presentations, digital storytelling, and video documentation for effective communication.
   - Provide constructive feedback on student projects and ensure continuous improvement.

III. COURSE CONTENT

Module-1:Introduction to Social Connect Responsibility	03Hrs

1. Identify the factors comprising the socio-cultural system and its impact on society
2. The concept of inter-relatedness of society and culture, socio-cultural dimensions, factors contributing to socio-cultural evolution.
3. Identifying problems in areas such as education, healthcare, environment, and infrastructure.

Module-2: Understanding Social Issues	03 Hrs

1. Understanding societal challenges in local and global contexts.
2. Role of engineers in addressing these issues.
3. Conducting preliminary field surveys and interviews

Module-3: Analyzing the Social Problem	03 Hrs

1. Understanding the economic, environmental, and societal impact of the problem
2. Ethical and moral considerations in problem-solving by Interaction with stakeholders (community members, NGOs, government bodies)
3. Root cause analysis using tools like SWOT, Fishbone Diagram, and Case Studies.

Module-4: Proposing Engineering Solutions 03 Hrs

1. Application of engineering knowledge to develop feasible solutions.
2. Use of technology for social good (IoT, AI, Renewable Energy, Smart Systems, etc.).
3. Sustainable and cost-effective approaches.
4. Feasibility analysis and implementation strategies.

Module-5: Documentation & Reporting 03 Hrs

1. Preparing a structured report with problem identification, analysis, proposed solutions, and implementation insights.
2. Creating presentations, videos, and other forms of project documentation.
3. Reflecting on personal learning and the social impact of the project.
4. Submission of a final report and group presentation.

IV.COURSE OUTCOMES

CO1	Students will be able to recognize and define real-world social issues, assessing their relevance and impact on communities.
CO2	Students will develop analytical skills to investigate the root causes of social problems and evaluate their economic, environmental, and ethical implications.
CO3	Students will apply engineering principles and innovative thinking to propose feasible, sustainable, and technology-driven solutions for identified social issues.
CO4	Students gain from stakeholder's interaction and develop presentation skills.

V.CO-PO-PSO MAPPING

PO/PSO	1	2	3	4	5	6	7	8		10	11	12
CO1			1			2	1	1	1			1
CO2			1			1	2	1	1			1
CO3			1			2	2	1	1			1
CO4			1			2	1	1	1			1

VI. Formative Assessment Details (CIE)

Continuous Internal Evaluation (CIE)& Rubrics: ***Refer to Annexure section -8***

VII. Learning Resources

VII (a). Reference Books :

1. C. N. Shankar Rao (2006) Sociology of Indian Society, 2nd, S. Chand publication
2. Nandan Nilekani, Imagining India: The Idea of a Renewed Nation, Penguin Books, 2009.
3. Gurcharan Das, India Unbound: From Independence to the Global Information Age, Anchor Books, 2002.
4. Raghuram G. Rajan, I Do What I Do, Harper Business, 2017.

VIII. Activity Based Learning

1. **Community Survey:** Students visit local communities (rural/urban) to identify real social issues (sanitation, education, healthcare, infrastructure)
2. **Collaboration with NGOs & CSR Units:** Partner with organizations working on social impact projects.
3. **Sustainability Planning:** Students draft plans for scaling up their solutions in a sustainable manner.
4. **Video Documentation:** Create short films showcasing their social project progress and community feedback.