Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY

[An Autonomous Institution, affiliated to VTU, Belgaum and Aided by Government of Karnataka]

Near Jnana Bharathi Campus, Mallathalli, Bangalore-560056

Aided By Govt. of Karnataka

DEPARTMENT OF MECHANICAL ENGINEERING

SYLLABUS & SCHEME

2023 - 2024

<table>
<tr><th colspan="4">OPEN ELECTIVE –C (SEVENTH SEMESTER)</th></tr>
<tr><th>Course Code</th><th>Subjects</th><th>Credits</th><td rowspan="4">Students can select any one of the open electives (Please refer to consolidated list of Dr AIT for open electives) offered by any Department.
Selection of an open elective is not allowed provided,
• The candidate has studied the same course during the previous semesters of the programme.
• The syllabus content of open elective is similar to that of Departmental core courses or professional electives.
• A similar course, under any category, is prescribed in the higher semesters of the programme.
Registration to electives shall be documented under the guidance of Programme Coordinator / Mentor.</td></tr>
<tr><td>18ME751</td><td>Power Plant Engineering</td><td>3</td></tr>
<tr><td>18ME752</td><td>Robotics</td><td>3</td></tr>
<tr><td>18ME753</td><td>Computer Integrated Manufacturing and Automation</td><td>3</td></tr>
<tr><td></td><td></td><td>3</td></tr>
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ADMISSION YEAR : 2020-21 ACADEMIC YEAR: 2023-24
SEMESTER : SEVENTH

COURSE TITLE: POWER PLANT ENGINEERING (OPEN ELECTIVE –C)		
Sub Code: 18ME751	**No of Credits : 3** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture Hours:39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**EME, Engineering Mathematics**	

COURSE OBJECTIVES:

1. To familiarize with Energy policy of India and trends of energy generation
2. To demonstrate layout and components of steam power plants, diesel engine power plants, hydroelectric power plants, nuclear power plants.
3. To implement principles of power generation through solar energy, wind energy, ocean, tidal energy & fuel cells.
4. To apply basic calculations to understand design principles of conventional energy conversion.
5. To demonstrate competence in understanding performance of energy conversion devices through experiments.

#	CONTENTS	Hrs.
UNIT-1	**THERMAL POWER PLANTS**	**08**
	Introduction: Energy sources for generation of electric power, energy policy of India, present status and future trends, major power plants in India. Thermal Power Plants: Selection of site, general layout of the plant, major components- Boilers, Economizers, Super-heaters, Air pre-heaters, fuels, fuel and ash handling equipment, High pressure Boilers, steam turbines, station heat balance and plant efficiency.	
UNIT-2	**DIESEL ENGINE POWER PLANT**	**08**
	Introduction; Applications of Diesel Engines in power field, Advantages and disadvantages diesel engine power plant, Types, General layout, Combustion in a CI engine, Performance characteristics, Supercharging, Layout of diesel engine power plant, Numerical problems.	
UNIT-3	**HYDROELECTRIC POWER PLANTS**	**08**
	Introduction; Classification of hydro-plants, selection of site, rain fall and run off, calculation of storage capacity, plant layout estimation of power available, selection of hydraulic turbines and their governing, general layout of hydro power plant.	
UNIT-4	**NUCLEAR POWER PLANT**	**08**
	Nuclear Power Plants: Introduction, Atomic structure and radio-activities nuclear reactions, binding energy, Nuclear Reactors, Types of reactors, Pressurized water reactors, boiling heater reactors, Heavy water-cooled and moderated (CANDU) reactor, Gas cooled reactors, Liquid metal cooled reactors, Indian Nuclear power installations, comparison between Nuclear and Thermal plants, Numerical problems.	
UNIT-5	**NON CONVENTIONAL POWER GENERATION**	**07**
	Introduction, Direct energy conversion, MHD, Thermionic and Thermoelectric power generation, Fuel cells, Geothermal energy, Hydrogen energy systems, Numericals.	

TEXT BOOKS

1. Power Plant Engineering, P. K. Nag, Tata McGraw Hill, 4 Edition, 2014.

2. A Text Book of Power Plant Engineering, R. K. Rajput, Laxmi publication, New Delhi, 4 Edition, 2007.

REFERENCE BOOKS

1. Power Plant Engineering, G.R. Nagpal and S.C. Sharma, Khanna Publishers, 16 Edition, 2012.

COURSE OUTCOMES: After completion of the course, students will be able to:

CO1: Describe the sources of energy, energy generation by Thermal power plants and its trends in India, working principles of various components of Thermal power plants.

CO2: Discuss the layout, generation of Electric energy, working principles of components of Diesel power plants and its Applications.

CO3: Explain Hydrology, required flow graphs for calculating the capacity, site selection and different components of hydroelectric power plant

CO4: Explain nuclear materials, principles of energy release and components of reactors and different types of nuclear reactors and nuclear waste disposal

CO5: Describe the different nonconventional energy conversion methods for power generation.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1	-	-	-	2	3	-	-	-	-	3
CO2	3	2	-	-	-	1	3	-	-	-	-	3
CO3	3	3	-	-	-	3	1	-	-	-	-	3
CO4	3	1	-	-	-	3	3	-	-	-	-	3
CO5	3	-	-	-	-	-	-	-	-	-	-	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1,												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2020-21 **ACADEMIC YEAR: 2023-24**
SEMESTER : SEVENTH

COURSE TITLE: ROBOTICS (OPEN ELECTIVE –C)		
Sub Code: 18ME752	**No of Credits : 3** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture Hours:39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
PRE-REQUISITES		

COURSE OBJECTIVES:

1. To understand the application of robots in an industry based on its structure
2. To understand the basic function of controllers
3. To analyse the position representation of points on various linkages with respect to other linkages using homogenous transportation matrices
4. To understand trajectory planning and to program robots for different operations using VAL-II and other methods
5. To understand the functions of vision system and applications for inspection in assembly

#	**Contents**	**hr**
UNIT-1	**INTRODUCTION TO ROBOTICS**	**07**
	Introduction, definition, automation and robotics, advantages and disadvantages, investment on robot, social impact, labour robots and productivity, management and robotics, overview of robots, advanced technological features of a modern robots, need for robots, the characteristics and application of future industrial robot.	
UNIT-2	**STRUCTURE OF ROBOTIC SYSTEM**	**08**
	Anatomy of robot, classification of robot, robot configuration Robotic system, robot links ,joints in robots, robot specifications, performance parameters, robot drive systems, hydraulic actuators pneumatic actuators, electric drives, steeped motors, wrists and motions, design of gripper fingers, problems.	
UNIT-3	**SENSORS**	**07**
	Introduction, classification of sensors and their functions, touch sensors, binary sensors, analog sensors, tactile sensors, proximity sensing, range sensing, and force-torque sensors.	
UNIT-4	**VISION SYSTEMS**	**08**
	Block diagram of vision system, constructional features of vidicon camera – lighting techniques and devices, analog to digital signal conversion - image storage. Image processing and analysis, Feature Extraction and Object recognition, components of digital image processing.	
UNIT-5	**COMPUTER –INTEGRATED MANUFACTURING SYSTEMS**	**09**
	Hierarchial computer control, flexible manufacturing systems - the FMS concept – transfer system-head changing FMS-variable mission manufacturing system, FMS s in japan, CAD/CAM systems, the factory of the future”	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Able to define brief history of robotics. Social and economic aspects of robotics, advantages and disadvantages of using robots in industries. Overview of robots present and future applications.
2. Explain the drives and control system required for various applications of robots.
3. Analyse Homogeneous transformation, kinematic and dynamic analysis of robots
4. Analyse Inverse kinematic and trajectory planning related problems and will be able to understand the concept of trajectory planning and write the program for robot for various applications.
5. have knowledge of Robotics, automation, robotics motion, sensors and control, machine vision, robotic programming and roles of robots in industry

Text Books:

1. Ganesh S .Hegde " industrial robotics" laxmi publications ltd 2006
2. Yoram Koren, "Robotics for Engineers", McGraw-Hill Book Co., 2001
3. Mikell P. Groover, Mitchel Weiss, Roger N. Nagel, Nicholas G. Odrey and Ashish Dutta, Industrial Robotics: Technology, Programming and Applications, 2nd Edition, Tata McGraw Hill, 2012.
4. Roland Siegwart, Illah R. Nourbakhsh, an d Davide Scaramuzza, "Introduction to Autonomous Mobile Robots, 2nd Edition, PHI, 2011.

REFERENCES:

1. Groover, M.P. "Industrial Robotics – Technology, Programming and Applications", McGraw-Hill, 2005
3. Fu.K.S. Gonzalz.R.C., and Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw-Hill Book Co., 2008
4. Janakiraman.P.A., "Robotics and Image Processing", Tata McGraw-Hill, 2005
5. Deb S.R. "Robotics Technology and Flexible Automation" Tata McGraw Hill, 2003.

MAPPING OF COs WITH POs												
COs/POs	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	3	1	1	1	2	1	3	1	2
CO3	3	3	3	2	2	1	1	1	2	3	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	2
CO5	3	3	3	1	2	1	1	1	1	2	1	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2020-21 ACADEMIC YEAR: 2023-24
SEMESTER : SEVENTH

COURSE TITLE : COMPUTER INTEGRATED MANUFACTURING and AUTOMATION (OPEN ELECTIVE –C)		
Sub Code: 18ME753	**No of Credits =03 L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites		

Course Objectives:

1. To impart knowledge of CIM and Automation and different concepts of automation by developing mathematical models.
2. To expose students to automated flow lines, assembly lines, Line Balancing Techniques, and Flexible Manufacturing Systems.
3. To expose students to computer aided process planning, material requirement planning, capacity planning etc.
4. To introduce the students to concepts of Additive Manufacturing, Internet of Things, and Industry 4.0 leading to Smart Factory.

UNIT	CONTENT	Hrs.
UNIT 1	**Introduction to CIM and Automation:** Automation in Production Systems, automated manufacturing systems- types of automation, reasons for automating, Computer Integrated Manufacturing, computerized elements of a CIM system, CAD/CAM and CIM. Mathematical models: production rate, production capacity, utilization and availability, manufacturing lead time, work-in process, Numerical problems and automation strategies.	**08**
UNIT 2	**Automated Production Lines and Assembly Systems:** Fundamentals, system configurations, applications, automated flow lines, buffer storage, control of production line, analysis of transfer lines, analysis of flow lines without storage, partial automation, analysis of automated flow lines with Storage buffer, fundamentals of automated assembly systems, numerical problems.	**07**
UNIT 3	**Flexible Manufacturing Systems:** Fundamentals of Group Technology and Flexible Manufacturing Systems, types of FMS, FMS components, Material handling and storage system, applications, benefits, computer control systems, FMS planning and design issues, Automated Storage and Retrieval Systems, AS/RS and Automatic parts identification systems and data capture. **Line Balancing:** Line balancing algorithms, methods of line balancing, numerical problems on largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights method.	**08**
UNIT 4	**Computerized Manufacture Planning and Control System:** Computer Aided Process Planning, Retrieval and Generative Systems, benefits of CAPP, Production Planning and Control Systems, Material Requirement Planning, inputs to MRP system, working of MRP, outputs and benefits, Capacity Planning, Computer Aided Quality Control, Shop floor control.	**08**

	Automated Assembly Systems: Parts feeding devices-elements of parts delivery system-hopper, part feeder, Selectors, feedback, escapement and placement. **Automated Guided Vehicle System**: Introduction, types, Vehicle guidance and routing, System management.	
UNIT 5	**Additive Manufacturing Systems:** Basic principles of additive manufacturing, slicing CAD models for AM, advantages and limitations of AM technologies, Additive manufacturing processes: Photo polymerization, material jetting, binder jetting, material extrusion, Powder bed sintering techniques, sheet lamination, direct energy deposition techniques, applications of AM. Hybrid manufacturing. **Future of Automated Factory:** Industry 4.0, functions, applications and benefits. Components of Industry 4.0, Internet of Things (IOT), IOT applications in manufacturing, Big-Data and Cloud Computing for IOT, IOT for smart manufacturing, influence of IOT on predictive maintenance, Industrial automation, supply chain optimization, supply-chain & logistics, cyber-physical manufacturing systems.	**08**

TEXT BOOKS:

1. Automation, Production system & Computer Integrated manufacturing, M. P. Groover" 4th Edition, 2015, Pearson Learning.
2. Principles of Computer Integrated Manufacturing, S. Kant Vajpayee, Prentice Hall India.
3. CAD/CAM/CIM, Dr P Radhakrishnan, 3rd edition, New Age International Publishers, New Delhi.

REFERENCE BOOKS

1. "CAD/CAM" by Ibrahim Zeid, Tata McGraw Hill.
2. "Principles of Computer Integrated Manufacturing", S.Kant Vajpayee, 1999, Prentice Hall of India, New Delhi.
3. "Work Systems and the Methods, Measurement and Management of Work", Groover M. P, Pearson/Prentice Hall, Upper Saddle River, NJ, 2007.
4. "Computer Automation in Manufacturing", Boucher, T. O., Chapman & Hall, London, UK, 1996.
5. "Introduction to Robotics: Mechanics and Control", Craig, J. J., 2nd Ed., Addison-Wesley Publishing Company, Readong, MA, 1989.
6. Internet of Things (IoT): Digitize or Die: Transform your organization. Embrace the digital evolution. Rise above the competition, by Nicolas Windpassinger, Amazon.
7. "Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press)
8. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 2nd Ed. (2015), Ian Gibson, David W. Rosen, Brent Stucker
9. "Understanding Additive Manufacturing", Andreas Gebhardt, Hanser Publishers, 2011
10. Industry 4.0: The Industrial Internet of Things, A press, 2017, by Alasdair Gilchrist.

COURSE OUTCOMES (COS): On completion of this course you should be able to:

CO1: Able to define Automation, CAD, CAM, CIM, and explain the differences between these concepts.

CO2: Explain the basics of automated manufacturing industries through mathematical models and analyse different types of automated flow lines.

CO3: Analyse the FMS, GT, AS/RS and automated flow lines to reduce down time and enhance productivity.

CO4: Design and development of various types of Computerized Manufacture Planning and Control System, materials handling systems, CAPP, MRP, capacity planning, shop floor control and CAQC.

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.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	3	1	1	1	2	1	3	1	2
CO3	3	3	3	2	2	1	1	1	2	3	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	2
CO5	3	3	3	1	2	1	1	1	1	2	1	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2020-21 **ACADEMIC YEAR: 2023-24**
SEMESTER : SEVENTH

COURSE TITLE : CONTROL ENGINEERING		
Sub Code: 18ME71	**No of Credits =04** **L-T-P-SS::4:0:0:0**	**No. of lecture hours/week : 04** **Total Number of Lecture hours : 52**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**Engineering Mathematics**	

COURSE OBJECTIVES:

1. Mathematical modeling of the mechanical systems using differential equations.
2. Deduction of Transfer functions using block Diagrams and signal flow graphs
3. Emphasize on transient characteristics and response of the systems and Routh-Hurwitz stability criteria
4. Analysis of frequency response characteristics of control systems.
5. Construction of root locus plots and to ascertain the stability of the control systems

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#	CONTENTS	Hrs
UNIT-1	**MECHANICAL CONTROL SYSTEMS**	**10**
	Introduction to the concept of automatic control systems, open loop and closed loop control systems, representation of feedback control systems, requirements of an ideal control system. Temperature control, speed control and flight control systems. Mathematical models**:** Transfer function models, models of mechanical systems (translational and rotational).	
UNIT-2	**BLOCK DIAGRAMS AND SIGNAL FLOW GRAPHS**	**08**
	Transfer Functions definition, blocks representation of systems, reduction of block diagrams, Mason's gain formula: signal flow graphs. Differences between Feedback Systems and Feed Forward Systems, Differences between Positive Feedback systems and Negative Feedback System.	
UNIT-3	**TRANSIENT AND STEADY STATE RESPONSE ANALYSIS**	**10**
	Introduction, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance in speed of response. System stability: Routh's -Hurwitz criterion; Types of controllers-proportional, integral proportional integral, proportional integral differential controllers. Compensation in control systems, lead-lag compensator.	
UNIT-4	**ROOT LOCUS PLOTS**	**12**
	Definition, general rules for constructing and analysis of closed loop and open loop systems using root locus plots. Effects of addition of poles and zeroes on stability of the systems. MATLAB: Root Locus Methods	
UNIT-5	**FREQUENCY RESPONSE ANALYSIS**	**12**
	Asymptotic Approximations: Bode Magnitude and Phase angle plots. Stability, Gain Margin & Phase Margin via Bode plot. Polar plots, Nyquist stability criterion, Stability analysis, Relative stability concepts, Gain margin and phase margin. MATLAB : Frequency Response Analysis	

TEXT BOOKS:

1. Modern Control Engineering, Ogata, 5th Edition , 2010, Prentice Hall of India, New Delhi.ISBN: 10: 0-13-615673-8, 13: 978-0-13-615673-4
2. Automatic Control Systems, Kuo, 3rd Edition, 2009, Prentice Hall of India, New Delhi, ISBN: 0-13-054973-8
3. Control Systems Engineering, 5th Edition, Norman S Nise, Wiley India - 2009

REFERENCE BOOKS:

1. Modern Control Systems, Richard.C.Dorf and Robert. H. Bishop, Addison Wesley,1999
2. System dynamics & control, Eronini-Umez,Thomson Asia pte Ltd. Singapore, 2002.
3. Feedback Control System, Schaum's series. 2001.
4. Automatic Control Systems, B C Kuo, F Golnaraghi, John Wiley & Sons, 2003.
5. Control Engineering: MATLAB Exercises Authors: Keviczky, L., Bars, R., Hetthessy, J., Banyasz, C.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Describe fundamentals of control elements and mathematical modeling
CO2: To understand the block diagram and signal flow graphs.
CO3: Analyze steady state and transient response of first and second order systems.
CO4: Evaluate the system stability through Bode and Nyquist plots.
CO5: Construction and stability analysis using root locus plots.

MAPPING OF COs WITH POs												
COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	1	1	2	0	0	1	0	3
CO2	3	3	2	1	1	0	2	0	0	1	0	2
CO3	3	3	2	1	1	0	2	0	0	1	0	2
CO4	3	3	3	2	1	0	2	0	0	1	0	3
CO5	3	3	2	2	1	0	2	0	0	1	0	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2020-21 **ACADEMIC YEAR: 2023-24**
SEMESTER : SEVENTH

COURSE TITLE : OPERATIONS RESEARCH		
Sub Code: 18ME72	**No of Credits =4** **L-T-P-SS::4:0:0:0**	**No. of lecture hours/week : 04** **Total Number of Lecture hours : 52**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**Engineering Mathematics**	

COURSE OBJECTIVES:

1. Impart knowledge of mathematics, basic and applied sciences.
2. Ability to identify, formulate and solve mechanical engineering problems based on data interpretation, design, experiment and analysis of results.
3. Learn effective engineering communication.
4. Ability to work in teams on multi-disciplinary projects in industry and research organizations.
5. Develop awareness of the ethical, professional and environmental implications of work in a global and societal context.

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION & SOLUTION OF LINEAR PROGRAMMING PROBLEMS**	**11**
	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. (Class Room teaching) The simplex method-canonical and standard forms of an LP problem, slack, surplus and artificial variables (Self study only Assignment not for SEE).	
UNIT-2	**TRANSPORTATION PROBLEM**	**10**
	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, maximization cases (online)	
UNIT-3	**ASSIGNMENT PROBLEM & SEQUENCING**	**10**
	Assignment Problem-formulation balanced and unbalanced types, application to maximization cases and travelling salesman problem (Numericals). Basic assumptions, sequencing using Johnson's algorithm, 'n' jobs 2 machines, 'n' jobs 3 machines, 'n' jobs 'm' machines without passing sequence, graphical solutions. **.:**	
UNIT-4	**PERT-CPM TECHNIQUES**	**11**
	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.	
UNIT-5	**GAME THEORY & REPLACEMENT THEORY**	**10**
	Formulation of games, types, solution of games with saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed	

	strategy games. Replacement items deteriorating with time, when money value remains same Replacement of items which fail suddenly; Individual replacement policy, Group replacement policy.	

TEXT BOOKS:

1. **Operations Research,** P K Gupta and D S Hira, Chand Publications, New Delhi - 2007
2. **Operations Research,** Taha H A, Pearson Education

REFERENCE BOOKS:

1. **Operations Research,** A P Verma, S K Kataria & Sons, 2008
2. **Operations Research,** Paneerselvan, PHI
3. **Operations Research,** A M Natarajan, P Balasubramani, Pearson Education, 2005
4. **Introduction to Operations Research,** Hiller and Liberman, McGraw Hill.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Define models for linear programming and convert the linear variable problems to a mathematical model and depict by graphical method.

CO2: Compute the minimum cost of transportation by NWCR, LCM and VAM method and then to find optimum solution by MODI method.

CO3: Find optimal assignment by Hungarian method.

CO4: Design a project network diagram and schedule the project activities and duration using PERT and CPM.

CO5: Illustrate the strategies of different players in a game and find the best strategy by graphical and dominance method.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	1	2	0	1	0	2	1	3	2	2
CO2	3	3	1	2	1	1	0	2	1	3	2	2
CO3	3	3	1	2	1	1	0	2	1	3	2	2
CO4	3	3	1	2	3	1	0	2	2	3	3	3
CO5	3	3	1	2	3	1	1	3	3	3	3	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2020-21 **ACADEMIC YEAR: 2023-24**
SEMESTER : SEVENTH

COURSE TITLE : COMPUTER INTEGRATED MANUFACTURING (PROFESSIONAL ELECTIVE - 3)		
Sub Code: 18ME731	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture Hours:39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**Manufacturing Process I and II, CAD/CAM**	

Course Objectives:

1. To impart knowledge of CIM and Automation and different concepts of automation by developing mathematical models.
2. To expose students to automated flow lines, assembly lines, Line Balancing Techniques, and Flexible Manufacturing Systems.
3. To expose students to computer aided process planning, material requirement planning, capacity planning etc.
4. To introduce the students to concepts of Additive Manufacturing, Internet of Things, and Industry 4.0 leading to Smart Factory.

UNIT	CONTENT	Hrs.
UNIT 1	**Introduction to CIM and Automation:** Automation in Production Systems, automated manufacturing systems- types of automation, reasons for automating, Computer Integrated Manufacturing, computerized elements of a CIM system, CAD/CAM and CIM. Mathematical models: production rate, production capacity, utilization and availability, manufacturing lead time, work-in process, Numerical problems and automation strategies.	**08**
UNIT 2	**Automated Production Lines and Assembly Systems:** Fundamentals, system configurations, applications, automated flow lines, buffer storage, control of production line, analysis of transfer lines, analysis of flow lines without storage, partial automation, analysis of automated flow lines with Storage buffer, fundamentals of automated assembly systems, numerical problems.	**08**
UNIT 3	**Flexible Manufacturing Systems:** Fundamentals of Group Technology and Flexible Manufacturing Systems, types of FMS, FMS components, Material handling and storage system, applications, benefits, computer control systems, FMS planning and design issues, Automated Storage and Retrieval Systems, AS/RS and Automatic parts identification systems and data capture. **Line Balancing:** Line balancing algorithms, methods of line balancing, numerical problems on largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights method.	**08**
UNIT 4	**Computerized Manufacture Planning and Control System:** Computer Aided Process Planning, Retrieval and Generative Systems, benefits of CAPP, Production Planning and Control Systems, Material Requirement Planning, inputs to MRP system, working of MRP, outputs and benefits, Capacity Planning, Computer Aided Quality Control, Shop floor control.	**08**

	Automated Assembly Systems: Parts feeding devices-elements of parts delivery system-hopper, part feeder, Selectors, feedback, escapement and placement. **Automated Guided Vehicle System**: Introduction, types, Vehicle guidance and routing, System management.	
UNIT 5	**Additive Manufacturing Systems:** Basic principles of additive manufacturing, slicing CAD models for AM, advantages and limitations of AM technologies, Additive manufacturing processes: Photo polymerization, material jetting, binder jetting, material extrusion, Powder bed sintering techniques, sheet lamination, direct energy deposition techniques, applications of AM. Hybrid manufacturing. **Future of Automated Factory:** Industry 4.0, functions, applications and benefits. Components of Industry 4.0, Internet of Things (IOT), IOT applications in manufacturing, Big-Data and Cloud Computing for IOT, IOT for smart manufacturing, influence of IOT on predictive maintenance, Industrial automation, supply chain optimization, supply-chain & logistics, cyber-physical manufacturing systems.	**07**

TEXT BOOKS:

1. Automation, Production system & Computer Integrated manufacturing, M. P. Groover" 4th Edition, 2015, Pearson Learning.
2. Principles of Computer Integrated Manufacturing, S. Kant Vajpayee, Prentice Hall India.
3. CAD/CAM/CIM, Dr P Radhakrishnan, 3rd edition, New Age International Publishers, New Delhi.

REFERENCE BOOKS

1. "CAD/CAM" by Ibrahim Zeid, Tata McGraw Hill.
2. "Principles of Computer Integrated Manufacturing", S.Kant Vajpayee, 1999, Prentice Hall of India, New Delhi.
3. "Work Systems and the Methods, Measurement and Management of Work", Groover M. P, Pearson/Prentice Hall, Upper Saddle River, NJ, 2007.
4. "Computer Automation in Manufacturing", Boucher, T. O., Chapman & Hall, London, UK, 1996.
5. "Introduction to Robotics: Mechanics and Control", Craig, J. J., 2nd Ed., Addison-Wesley Publishing Company, Readong, MA, 1989.
6. Internet of Things (IoT): Digitize or Die: Transform your organization. Embrace the digital evolution. Rise above the competition, by Nicolas Windpassinger, Amazon.
7. "Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press)
8. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 2nd Ed. (2015), Ian Gibson, David W. Rosen, Brent Stucker
9. "Understanding Additive Manufacturing", Andreas Gebhardt, Hanser Publishers, 2011
10. Industry 4.0: The Industrial Internet of Things, A press, 2017, by Alasdair Gilchrist.

COURSE OUTCOMES (COS): On completion of this course you should be able to:

CO1: Able to define Automation, CAD, CAM, CIM, and explain the differences between these concepts.

CO2: Explain the basics of automated manufacturing industries through mathematical models and analyse different types of automated flow lines.

CO3: Analyse the FMS, GT, AS/RS and automated flow lines to reduce down time and enhance productivity.

CO4: Design and development of various types of Computerized Manufacture Planning and Control System, materials handling systems, CAPP, MRP, capacity planning, shop floor control and CAQC.

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.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	3	1	1	1	2	1	3	1	2
CO3	3	3	3	2	2	1	1	1	2	3	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	2
CO5	3	3	3	1	2	1	1	1	1	2	1	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2020-21 **ACADEMIC YEARS: 2023-24**
SEMESTER : SEVENTH

COURSE TITLE : RAPID PROTOTYPING (PROFESSIONAL ELECTIVE - 3)		
Sub Code: 18ME732	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**Manufacturing Processes**	

COURSE OBJECTIVES:

1. Describe the manufacturing techniques of rapid prototyping process.
2. Understand and apply fundamentals of rapid prototyping techniques.
3. Understand the concepts modelers
4. Analyze the different Rapid tooling methods.
5. Understand the rapid prototyping software and its applications.

#	CONTENTS	Hrs.
UNIT-1	**INTRODUCTION:**	**07**
	Prototyping, Traditional Prototyping Vs. Rapid Prototyping (RP), Need for the compression in product development, history of RP systems, Usage of RP parts, Generic RP process, Distinction between RP and CNC, other related technologies, Classification of RP. Survey of applications, Growth of RP industry, general steps in producing components using RP technology.	
UNIT-2	**RP SYSTEMS:**	**08**
	STEREO LITHOGRAPHY SYSTEMS: Principle, Process parameter, Process details, Data preparation, data files and machine details, Application. **SELECTIVE LASER SINTERING (SLS) PROCESS:** Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications. **FUSION DEPOSITION MODELLING**: Principle, Process parameter, Path generation, Applications.	
UNIT-3	**SOLID GROUND CURING AND CONCEPTS MODELERS:**	**08**
	Principle of operation, Machine details, Applications. **Laminated Object manufacturing**: Principle of operation, LOM materials Process details, application. **CONCEPTS MODELERS:** Principle, Thermal jet printer, Sander's model market, 3-D printing. Generis RP systems (GS) 5, object Quadra systems, comparisons of different RP technologies.	
UNIT-4	**RAPID TOOLING:**	**08**
	Indirect Rapid tooling, Silicone rubber tooling, Aluminum filled epoxy tooling, Spray metal tooling, Cast Kirksite, 3Q Keltool, etc. Direct Rapid Tooling Direct. AIM. RAPID TOOLING**:** Quick Cast process, Copper polyamide, Rapid Tool, DMLS, Prometal, Sand casting tooling, Laminate tooling soft Tooling vs. Hard tooling.	
UNIT-5	**RAPID PROTOTYPING SOFTWARE AND ITS APPLICACTIONS:**	**08**
	STL files, Overview of Solid view, Magics, Imics, Magic communicator, etc. Internet based software, Collaboration too factors influencing accuracy. Data	

	preparation errors, Part building errors, Error in finishing, Influence of build orientation. RP Applications: Design, Engineering Analysis and planning applications, Rapid Tooling, Reverse Engineering, Medical Applications of RP.	

TEXT BOOKS:

1. Stereo Lithography and other RP & M Technologies, Paul F. Jacobs: SME, NY 1996
2. Rapid Manufacturing, Flham D.T &Dinjoy S.S Verlog London 2001

REFERENCE BOOKS:

1. Rapid Prototyping, Terry Wohler's Report 2000" Wohler's Association 2000
2. Rapid Prototyping Materials, Gurumurthi, IISc Bangalore.
3. Rapid Automated, Lament wood. Indus press New York

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Describe the fundamentals of rapid prototyping technology and classification of RP techniques to prepare prototypes for a different product.

CO2: Study RP techniques such as SLA, SLS and FDM based on their applicability, materials used and advantages.

CO3: Study RP systems such as SGC and LOM and also specifically designed concept modelers can adopt to create various models quickly and inexpensively.

CO4: Apply rapid tooling technique for the different specified product easily.

CO5: Create RP models using different software tools. Analyze advanced RP techniques for their suitability, merits and its applications.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	3	1	1	1	2	1	1	1	2
CO3	3	3	3	2	2	1	1	1	2	1	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	2
CO5	3	3	2	2	1	1	1	1	2	1	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2020-21 **ACADEMIC YEAR: 2023-24**
SEMESTER : SEVENTH

COURSE TITLE : PROJECT MANAGEMENT (PROFESSIONAL ELECTIVE - 3)		
Sub Code: 18ME733	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**Elementary knowledge of Calculus and Probability**	

Course Objective:

1. Describe Concepts of Project Management.
2. Prepare Scope Document and Communication Plan.
3. Demonstrate the skills, including Work Breakdown Structure and Draw up a plan.
4. Explain the principles of project scheduling tools and technique of project management.
5. Demonstrate Risk management and Understand Managing Projects.

UNITS	CONTENTS	Hrs.
UNIT- 1	**PROJECT MANAGEMENT CONCEPTS**	**08**
	Concepts of Project Management: Concepts of a project, Project Life Cycle, Project Governance, Phases of project life cycle, The need for Project Portfolio Management System.	
UNIT- 2	**DEFINING THE PROJECT**	**08**
	Defining the Scope, Establishing Project Priorities, preparation of Work Breakdown Structure (WBS), Responsibility Matrices, and Project Communication Plan. Feasibility study of a project.	
UNIT- 3	**PROJECT PLAN: NETWORK DIAGRAMS**	**08**
	Factors influencing Quality of Estimate, Methods of Estimation, Types of Costs. Developing Project Network, Simple Network Diagrams, Computation of Critical Path, Forward and Backward pass, Slack, Extended Network Techniques.(Simple numerical)	
UNIT- 4	**RESOURCE SCHEDULING**	**07**
	Types of Resource Constraints, Resource Allocation Methods, Splitting, Project Cost Baselines, Rationale and Options f or Accelerating Project Completion.(Simple numerical)	
UNIT- 5	**MANAGING PROJECTS AND RISKS**	**08**
	Five Stage Team Development Model, Project Team Pitfalls, Risk Management: Risk Identification, Risk assessment, Risk Response, Change Control Management.	

TEXT BOOKS:

1. Project Management, Clifford Grey, 6 Edition, Mcgraw Hill

REFERENCE BOOKS:

1. Project Management a System approach to planning Scheduling & Controlling-Harold Kerzner, 10th edition 2009, John wiley & sons.
2. Project Management –Bhavesh M.Patel, Vikas Publication House, 2002.

3. PERT & CPM. L.S. Srinath, Affiliated East West Press Pvt. Ltd 2002.
4. Project planning scheduling & control James P.Lawis, Meo Publishing Company, 5th edition 2010.

COURSE OUTCOMES: On completion of the course, student should be able to:
CO1: Appreciate the project management function in any organization.
CO2: Explain importance of scope, document and communication plan.
CO3: Explain importance of skills, including Work Breakdown Structure and Draw Up a Plan.
CO4: Explain various principles of project scheduling tools and technique of project management.
CO5: Explain Risk management and Understand Managing Projects.

MAPPING OF COs WITH POs												
COs/POs	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	0	2	0	0	0	0	0	0	2
CO2	3	3	2	1	2	0	2	0	0	0	0	2
CO3	3	3	2	1	2	0	0	0	0	0	0	2
CO4	3	3	3	3	2	2	0	0	0	2	0	2
CO5	3	3	2	1	3	3	3	0	0	2	0	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2020-21 **ACADEMIC YEAR: 2023-24**
SEMESTER : SEVENTH

COURSE TITLE: SOLAR THERMAL ENGINEERING (PROFESSIONAL ELECTIVE - 3)		
Sub Code: 18ME734	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	**Elements of Mechanical Engineering**	

COURSE OBJECTIVES:

1. To provide opportunity for students to get acquainted on man, energy, thermal devices and applications.
2. To provide students with a sound foundation to formulate, solve and analyze basic solar radiation and its geometry.
3. To familiarize the students with liquid flat plate collector's energy balance and its performance affecting parameters.
4. To understand the concept of solar air heating and its thermal energy storage.
5. To impart the vital knowledge of concentrating collector technologies to suffice the present day energy crisis.

#	CONTENTS	h
UNIT-1	**INTRODUCTION**	**08**
	THE ENERGY SCENARIO: Man and Energy, World's Population and Reserves of Commercial Energy Sources, India's Production and Reserves, Energy Alternatives. THE SOLAR ENERGY OPTION - AN OVERVIEW OF THERMAL APPLICATIONS: Devices for Thermal Collection and Storage, Thermal Applications, Some Observations.	
UNIT-2	**SOLAR RADIATION**	**08**
	RADIATION – GENERAL: Solar Radiation Outside the Earth's Atmosphere, Solar Radiation at the Earth's Surface, Instruments for Measuring Solar Radiation and Sunshine, Solar Radiation Data. RADIATION – GEOMETRY: Solar Radiation Geometry, Empirical Equations for Predicting the Availability of Solar Radiation, Solar Radiation on Tilted Surfaces.	
UNIT-3	**LIQUID FLAT PLATE COLLECTORS**	**08**
	INTRODUCTION: General Performance Analysis, Transmissivity of the Cover System, Transmissivity-Absorptivity Product, Overall Loss Coefficient and Heat Transfer Correlations, Collector Efficiency and Heat Removal Factors. PERFORMANCE ANALYSIS: Effects of Various Parameters on Performance, Analysis of Collectors Similar to the Conventional Collector, Transient Analysis, Testing Procedures, Alternatives to the Conventional Collector.	
UNIT-4	**HEATING AND STORAGE**	**07**

	SOLAR AIR HEATERS: Introduction, Performance Analysis of A Conventional Air Heater, Other Types of Air Heaters, Testing Procedures. THERMAL ENERGY STORAGE: Introduction, Sensible Heat Storage, Latent Heat Storage, Thermochemical Storage.	
UNIT-5	**CONCENTRATING COLLECTORS**	**08**
	GENERAL: Introduction, Flat Plate Collectors with Plane Reflectors, Cylindrical Parabolic Collector. ADVANCED: Compound Parabolic Collector, Paraboloid Dish Collector, and Central Receiver Collector.	

TEXT BOOKS:

1. Solar Energy- Principles of thermal collection and storage, S.P Sukhatme and J.K. Nayak, 3rd Edition, 2009, Tata Mc-Graw Hill Publications.

REFERENCE BOOKS:

1. Solar Energy Utilization, G.D.Rai, 2004, Khanna Publishers.
2. Solar Engineering of thermal processes, Duffie, J.A. & Beckman, W.A., 4th Edition, 2013, John Wiley & Sons.

COURSE OUTCOMES (CO): On completion of the course, student should:

CO1: Identify the energy sources and its alternatives; understand the need for thermal devices and their applications.

CO2: Acquire knowledge of fundamentals of solar radiation measurements and its geometry.

CO3: Understand the principle of liquid flat plate collector and its performance affecting vital parameters.

CO4: Analyze the working principle of solar air heating and thermal energy storage

CO5: Describe the various types of concentrating collectors and their role in energy crisis solving.

MAPPING OF COs WITH POs												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	0	0	3	3	2	0	0	0	2
CO2	3	2	2	2	2	2	3	2	0	0	0	2
CO3	3	2	2	1	2	2	3	2	0	0	0	2
CO4	3	2	2	1	2	2	3	2	0	0	0	2
CO5	3	2	2	1	2	2	3	2	0	0	0	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2020-21 **ACADEMIC YEAR: 2023-24**
SEMESTER : SEVENTH

COURSE TITLE : MECHANICS OF VISCOELASTIC MATERIALS		
Sub Code: 18ME735	**No of Credits =03** **L-T-P-SS:: 3:0:0:0**	**No. of lecture hours/week: 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Engineering Mathematics, Engineering Chemistry, Material Science**	

COURSE OBJECTIVES:

1. Understanding the structure of Viscoelastic materials find applications in a wide variety of areas such as aerospace & surface transport components, sporting goods, consumer durables and biomedical implants.
2. The course will involve modelling and experimental aspects of the mechanics of viscoelastic materials.
3. Understanding the mechanics of these time-dependent materials is crucially important to engineers in many disciplines and provide the knowledge of viscoelastic measurements.
4. Understanding the transitions and relaxation processes in polymers.
5. The course contents are targeted towards a general understanding of the mechanics of viscoelastic materials with interdisciplinary emphasis. Students from different backgrounds such as from applied mechanics, aerospace, civil, chemical and mechanical engineering may find the course useful.

UNIT	CONTENTS	Hrs
UNIT-1	**INTRODUCTION**	**08**
	Introduction to Viscoelasticity, review of the structure of viscoelastic materials such as plastics, rubbers and biological tissues, Linear viscoelasticity, constitutive equations using mechanical analogs. **PHENOMENOLOGICAL TREATMENT OF VISCOELASTICITY** Elastic Modulus, Transient Experiments, Dynamic Experiments Boltzmann Superposition Principle, Relationship Between the Creep Compliance and the Stress Relaxation Modulus, Relationship Between Static and Dynamic Properties.	
UNIT-2	**VISCOELASTIC MODELS**	**07**
	Mechanical Elements, Maxwell Model, Voigt Model, Generalized Maxwell Model, Voigt-Kelvin Model, Distributions of Relaxation and Retardation Times, Molecular Theories, Application of Flexible-Chain Models to Solutions, The Zimm Modification, Extension to Bulk Polymer, Reptation.	
UNIT-3	**TIME TEMPERATURE CORRESPONDENCE & VISCOELASTIC MEASUREMENTS**	**08**
	Four regions of Viscoelastic behaviour, modulus-temperature curve of various regions of viscoelastic behaviour, Time-Temperature Superposition, Master Curves. **VISCOELASTIC MEASUREMENTS** Biomedical instrumentation provides the facilities of Biopac, ECG, EEG, EMG and heart rate variation recording system, Spirometer, Atria make ECG recording machine, Pulse oximeter.	
UNIT-4	**TRANSITIONS AND RELAXATION IN POLYMERS**	**08**

	Phenomenology of the Glass Transition, Theories of the Glass Transition, Free-Volume Theory, Thermodynamic Theory, Kinetic Theories, Structural Parameters Affecting the Glass Transition, Relaxations in the Glassy State, Relaxation Processes in Networks, Physical Relaxation, Chemical Processes.	
UNIT-5	**DIELECTRIC AND NMR METHODS**	**08**
	Dielectric Methods, Phenomenology, Molecular Interpretation of Dielectric Constant, Interfacial Polarization, Application to Polymers, Experimental Methods, Application of Dielectric Relaxation to Polymethyl Methacrylate, Comparisons Between Mechanical and Dielectric Relaxation for Polymers, Nuclear Magnetic Resonance Methods.	

TEXT BOOKS

1. M. T. Shaw and W. J. MacKnight, Introduction to Polymer Viscoelasticity, 3rd Ed., Wiley-Interscience, 2005.
2. I. M. Ward, J. Sweeny, The Mechanical Properties of Solid Polymers, 2nd Ed., Wiley, 2004.
3. A.S.Wineman and K.R.Rajagopal, Mechanical Response of Polymers: An Introduction, Cambridge University Press, 2000.
4. Handbook of Biomedical Instrumentation, R.S. Khandpur, McGraw-Hill Education, 1987 - Diagnostic imaging - 702 pages, 1 Review, Describing the physiological basis and engineering, principles of electro-medical equipment

REFERENCE BOOKS

1. E. Riande, R. Diaz-Calleja, M. G. Prolongo, R. M. Masegosa, C. Salom, Polymer viscoelasticity, CRC Press, 1999
2. W. N. Findley, J. S. Lai and K. Onaran, Creep and Relaxation of Nonlinear Viscoelastic Materials, Dover, 1989.
3. A. C. Pipkin, Lectures on Viscoelasticity Theory, 2nd Ed., Springer, 1986
4. R. M. Christensen, Theory of Viscoelasticity, Dover, 2nd Ed., 1982
5. J. D. Ferry, Viscoelastic Properties of Polymers, 3rd Ed., Wiley, 1980.

COURSE OUTCOMES: After completion of the course, students will be able to:

CO1: Analyze the structure of Viscoelastic materials such as plastics, rubbers and biological tissues.

CO2: Develop models for Viscoelastic materials.

CO3: Design experiments to characterize the mechanical response of viscoelastic materials and recognize measurements necessity.

CO4: Compile the transitions and relaxation processes in polymers.

CO5: Evaluate the mechanics of viscoelastic materials with interdisciplinary emphasis.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	3	1	1	1	2	1	1	1	2
CO3	3	3	3	2	2	1	1	1	2	1	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	2
CO5	3	3	2	2	1	1	1	1	2	1	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2020-21 **ACADEMIC YEAR: 2023-24**
SEMESTER : SEVENTH

COURSE TITLE : SMART MATERIALS (PROFESSIONAL ELECTIVE - 4)		
Sub Code: 18ME741	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	**Material Science, Composite Materials**	

COURSE OBJECTIVES:

1. The aim of this course is to integrate research results with curriculum development for the benefit of the students in physics, materials science and engineering civil and structural engineering, mechanical and aerospace engineering, industrial and systems engineering, as well as electrical and electronic engineering.
2. The fundamentals of smart materials, device and electronics, in particular those related to the development of smart structures and products.
3. The skills, knowledge and motivation in the design, analysis and manufacturing of smart structures and products.

#	CONTENTS	Hrs.
UNIT-1	**INTRODUCTION TO SMART MATERIALS**	**07**
	Characteristics, properties and applications of composites and ceramic materials, Smart materials and their types, concepts of Electro-magnetic materials and shape memory alloys-processing and characteristics.	
UNIT-2	**SMART STRUCTURES**	**08**
	Types of smart Structures, potential feasibility of smart structures, key elements of smart structures, applications of smart structures. Piezoelectric materials, properties, piezoelectric constitutive relations, poling and coercive field, field strain relation. Hysteresis, creep and strain rate effects, inchworm linear motor.	
UNIT-3	**SENSING AND ACTUATION**	**08**
	Principles of electromagnetic, acoustics, chemical and mechanical sensing and actuation, Types of sensors and their applications, signal processing, principals and characterization of sensors. **Piezoelectric Sensing and Actuation:** Cantilever Piezoelectric actuator model, Properties of Piezoelectric materials, Applications.	
UNIT-4	**SHAPE MEMORY ALLOY**	**08**
	Experimental Phenomenology, Shape Memory Effect, phase transformation, super elasticity, Tanaka's constitutive model, SME testing of SMA wires, vibration control through SMA, Testing of super elasticity, Applications Of SMA. **ER AND MR FLUIDS:** Mechanisms and properties, fluid composition and behavior, The Bingham plastic and related models, pre-yield response. Post-yield flow applications in clutches, dampers and others.	
UNIT-5	**VIBRATION ABSORBERS and MEMS**	**08**
	VIBRATION ABSORBERS: Series and parallel damped vibrations (overview), active vibration absorbers, fiber optics, physical phenomena, characteristics, fiber optics in crack detection, applications, biomimetics. **MEMS:** Mechanical properties of MEMS materials, scaling of mechanical	

	systems, fundamentals of theory, the intrinsic characteristics of MEMS, miniaturization, microelectronics integration. **Case Studies:** MEMS Magnetic actuators, BP sensors, Microphone, Acceleration sensors.	

TEXT BOOKS:

1. **'Analysis and Design',** A. V. Srinivasan, 'Smart Structures –Cambridge University Press, New York, 2001, (ISBN : 0521650267)
2. **'Smart Materials and Structures',** M V Gandhi and B S Thompson Chapmen & Hall, London, 1992 (ISBN : 0412370107)

REFERENCE BOOKS:

1. **'Smart Materials and Structures',** Banks HT, RC Smith, Y Wang, Massow S A, Paris 1996
2. **G P Gibss'Adaptive Structures',** Clark R L, W R Saunolers, Jhon Wiles and Sons, New York, 1998
3. **An introduction for scientists and Engineers',**EsicUdd, Optic Sensors :Jhon Wiley & Sons, New York, 1991 (ISBN : 0471830070).

COURSE OUTCOMES: On completion of this COURSE, students should be able to:
CO1: Understand the physical principles underlying the behaviour of smart materials;
CO2: Analyze the properties of smart structures, Piezo electric materials with the applications and select suitable procedure for fabrication.
CO3: Understand the engineering principles in smart sensor, actuator and technologies
CO4: Explain the principle concepts of ER & MR Fluids and shape memory alloys with principles of working.
CO5: Describe the methods of controlling vibration using smart systems and fabrication methods of MEMS. Explain the principle concepts of Biomimetic, Fibre optics and actuation with principles of working.

MAPPING OF COs WITH POs												
COs/PO	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO1**	**PO1**	**PO1**
CO1	3	3	3	3	2	1	1	1	1	1	2	1
CO2	3	3	2	3	2	1	1	1	1	1	2	1
CO3	3	3	2	3	3	1	1	1	1	1	2	1
CO4	3	3	3	3	2	1	1	1	1	1	2	1
CO5	3	3	3	3	2	1	1	1	1	1	2	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2020-21 **ACADEMIC YEAR: 2023-24**
SEMESTER : SEVENTH

COURSE TITLE : HIGH ENTROPY ALLOYS (PROFESSIONAL ELECTIVE - 4)		
Sub Code: 18ME742	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**Elements of Mechanical Engineering**	

COURSE OBJECTIVES:

1. To provide opportunity for students to get acquainted with the history, birth and basic concepts of alloys.
2. To provide students with a sound foundation to formulate, solve and analyze phase selection and alloy design in the twenty first century.
3. To familiarize the students with synthesis, processing and solid solutions.
4. To understand the concept of intermetallic and interstitial compounds, metallic glasses and structural properties.
5. To impart the vital knowledge of functional properties, applications and future.

#	CONTENTS	Hrs.
UNIT-1	**HISTORY, BIRTH AND BASIC CONCEPTS OF ALLOYS**	**08**
	The coming of alloys, Special alloys, The coming of multi-component HEAs, Classification of phase diagrams and alloy systems, Definition of HEAs, Composition of notations, Four core effects of HEAs	
UNIT-2	**PHASE SELECTION AND ALLOY DESIGN IN THE 21st CENTURY**	**08**
	ICME and materials genome strategies, Predicting solid solubility from Hume-Rothery rules, Mutual solubility and phase transformation tendency in HEAs, Parametric approaches to predict crystalline solid solution and metallic glass, Pettifor map approach to predict the formation of intermetallic compound, Quasicrystal and glass phase separation approach to find single phase HEAs, Integrated computational material engineering.	
UNIT-3	**SYNTHESIS, PROCESSING AND SOLID SOLUTIONS**	**09**
	Melting and casting route, Solid state processing route, HA and HEA based coatings, Combinatorial materials synthesis, Solid solution formation in equatomic HEAs, Solid solution formation in non-equatomic HEAs, Microstructure of HEAs, Role of sluggish diffusion in phase evolution of HEAs, Thermal stability of HEAs.	
UNIT-4	**INTER-METALLIC & INTER-STITIAL COMPOUNDS, METALLIC GLASSES AND STRUCTURAL PROPERTIES**	**07**
	Intermetallic compounds, Interstitial compounds (HAGG phases), Metallic glasses, Mechanical properties, Wear properties, Electrochemical properties, Oxidation behavior.	
UNIT-5	**APPLICATIONS, FUNCTIONAL PROPERTIES AND FUTURE SCOPE**	**08**

	Diffusion barrier properties, Electrical properties, Thermal properties, Magnetic properties, Hydrogen storage properties, Irradiation resistance, Catalytic properties, Goals of property involvement, Advanced applications demanding new materials, Examples of applications, Patents on HEAs and related materials, Future directions	

TEXT BOOKS:

1. High Entropy Alloys by B S Murthy, J W Yeh and S Ranganathan, Elsevier 2014, ISBN 978-0-12-800251-3

REFERENCE BOOKS:

2.High-Entropy Alloys-Fundamentals and Applications by Michael C Gao, Jien-Wei Yeh, Peter K Liaw, Yong Zhang, Springer, ISBN 978-3-319-27011-1

COURSE OUTCOMES (CO): On completion of the course, student should:

CO6: Identify the history, birth and basic concepts of alloys.

CO7: Acquire knowledge of fundamentals of phase selection and alloy design in the twenty first century

CO8: Understand the principles of synthesis, processing and solid solutions

CO9: Analyze the working principle of intermetallic and interstitial compounds, metallic glasses and structural properties

CO10: Describe the various types of functional properties, applications and future.

MAPPING OF COs WITH POs												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	0	0	3	3	2	0	0	0	2
CO2	3	2	2	2	2	2	3	2	0	0	0	2
CO3	3	2	2	1	2	2	3	2	0	0	0	2
CO4	3	2	2	1	2	2	3	2	0	0	0	2
CO5	3	2	2	1	2	2	3	2	0	0	0	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2020-21 **ACADEMIC YEAR: 2023-24**
SEMESTER : SEVENTH

COURSE TITLE: TRIBOLOGY AND BEARING DESIGN (PROFESSIONAL ELECTIVE - 4)		
Sub Code: 18ME743	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**Fluid Mechanics, KOM, DOM**	

COURSE OBJECTIVES:

1. To educate the students on the importance of friction, the related theories/laws of sliding and rolling friction and the effect of viscosity of lubricants.
2. To expose the students to the consequences of wear, wear mechanisms, wear theories and analysis of wear problems.
3. To make the students understand the principles of lubrication, lubrication regimes, theories of hydrodynamic, hydrostatic and journal bearings
4. To expose the students to the factors influencing the selection of bearing materials for different sliding applications.
5. To introduce the concepts of antifriction, porous and magnetic bearings.

UNIT	CONTENTS	Hrs.
UNIT-1	**Introduction to tribology:** Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication Classification of contacts, lubrication theories, Effect of pressure and temperature on viscosity. Newton's Law of viscous forces, Flow through stationary parallel plates. Hagen's Poiseuille's theory, Numerical problems. **Friction and Wear** Origin, friction theories, measurement methods, friction of metals and non-metals. Classification and mechanisms of wear, delamination theory, debris analysis, testing methods and standards.	**07**
UNIT-2	**Hydrodynamic Lubrication**: Concept of lightly loaded bearings, Petroff's equation. Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynolds equation in two dimensions with assumptions. Introduction to idealized slide bearing with fixed shoe and Pivoted shoes. Expression for load carrying capacity. Location of center of pressure, effect of end leakage on performance, Numerical problems	**08**
UNIT-3	**Hydrostatic Lubrication:** Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing, numerical examples. **Bearing Materials:** Commonly used bearings materials, and properties of typical bearing materials. Advantages and disadvantages of bearing materials **EHL Contacts**: Introduction to Elasto - hydrodynamic lubricated bearings. Introduction to 'EHL' constant. Grubin type solution.	**08**
UNIT-4	**Journal Bearings:** Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Sommerfeld number and its	08

	significance, short and partial bearings, Comparison between lightly loaded and heavily loaded bearings, effects of end leakage on performance, Numerical problems.	
UNIT-5	**Antifriction bearings**: Advantages, selection, nominal life, static and dynamic load earing capacity, probability of survival, equivalent load, cubic mean load, bearing Mountings. **Porous Bearings:** Introduction to porous and gas lubricated bearings. Governing differential equation for gas lubricated bearings, Equations for porous bearings and working principal, Fretting phenomenon and its stages. **Magnetic Bearings:** Introduction to magnetic bearings, Active magnetic bearings. Different equations used in magnetic bearings and working principal. Advantages and disadvantages of magnetic bearings, Electrical analogy, Magneto-hydrodynamic bearings.	08

TEXT BOOKS:

1. Mujamdar.B.C "Introduction to Tribology of Bearing", Wheeler Publishing, New Delhi 2001
2. Radzimovsky, "Lubrication of Bearings - Theoretical principles and design" Oxford press Company, 2000.

REFERENCE BOOKS

1. Dudley D.Fulier “Theory and practice of Lubrication for Engineers", New York Company.1998
2. Moore "Principles and applications of Tribology", Pergamon press, 1975.
3. Oscar Pinkus, BenoSternlicht, “Theory of hydrodynamic lubrication”, McGraw-Hill, 1961.
4. G W Stachowiak, A W Batchelor ,“Engineering Tribology”, Elsevier publication 1993.
5. Hydrostatic and hybrid bearings, Butterworth 1983.
6. F. M. Stansfield, Hydrostatic bearings for machine tools and similar applications, Machinery Publishing, 1970.
7. Introduction to Tribology B. Bhushan John Wiley & Sons, Inc., New York 2002

COURSE OUTCOMES (CO):

At the end of the course, the student will be able to:
CO1: Understand the fundamentals of tribology and associated parameters.
CO2: Apply concepts of tribology for the performance analysis and design of components experiencing relative motion.
CO3: Analyse the requirements and design hydrodynamic journal and plane slider bearings for a given application.
CO4: Select proper bearing materials and lubricants for a given tribological application.
CO5: Apply the principles of surface engineering for different applications of tribology.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	0	0	3	3	2	0	0	0	2
CO2	3	2	2	2	2	2	3	2	0	0	0	2
CO3	3	2	2	1	2	2	3	2	0	0	0	2
CO4	3	2	2	1	2	2	3	2	0	0	0	2
CO5	3	2	2	1	2	2	3	2	0	0	0	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2020-21 **ACADEMIC YEAR: 2023-24**
SEMESTER : SEVENTH

COURSE TITLE: POWER PLANT ENGINEERING (PROFESSIONAL ELECTIVE - 4)		
Sub Code: 18ME744	**No of Credits =3** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks: 50**
Pre-requisites	**EME, Engineering Mathematics**	

COURSE OBJECTIVES:

1. To familiarize with Energy policy of India and trends of energy generation
2. To demonstrate layout and components of steam power plants, diesel engine power plants, hydroelectric power plants, and nuclear power plants.
3. To implement principles of power generation through solar energy, wind energy, ocean, tidal energy & fuel cells.
4. To apply basic calculations to understand design principles of conventional energy conversion.
5. To demonstrate competence in understanding performance of energy conversion devices through experiments.

#	CONTENTS	Hrs.
UNIT-1	**ECONOMICS OF POWER GENERATION**	**08**
	Introduction, Energy policy of India, Terms and Definition: Connected load, Demand, Maximum load or peak load, Demand facto, Load factor, Diversity factor, Utilization factor, Plant capacity factor, Plant use factor, Types of load, Load curves, Load duration curve, etc., Principles of power plant design ,Location of power plant, Cost analysis, Selection of type of generation, Selection of power plant equipment, Economics in plant selection, Factors affecting economics of generation and distribution of power, Performance and operating characteristics of power plant. Economic load sharing, Tariff for electrical Energy, Numerical.	
UNIT-2	**THERMAL POWER PLANTS**	**08**
	Introduction: Energy sources for generation of electric power, present status and future trends, Thermal Power Plants: Selection of site, general layout of the plant, major components- Boilers, Economizers, Super-heaters, Air pre-heaters, fuels, principle of fuel burning, pulverizing of fuels and burning, fuel and ash handling equipment, High pressure Boilers, steam turbines, station heat balance and plant efficiency.	
UNIT-3	**DIESEL ENGINE POWER PLANT**	**08**
	Introduction; Applications of Diesel Engines in power field Advantages and disadvantages diesel engine power plant, Types, General layout, Combustion in a CI engine, Performance characteristics, Supercharging, Layout of diesel engine power plant, Numericals.	
	HYDROELECTRIC POWER PLANTS	
	Introduction; Classification of hydro-plants, selection of site, rain fall and run off calculation of storage capacity, plant layout estimation of power available,	

	selection of hydraulic turbines and their governing, general layout of hydro power plant.	
UNIT-4	**NUCLEAR POWER PLANT**	**08**
	Nuclear Power Plants: Introduction, Atomic structure and radio-activities nuclear reactions, binding energy, Nuclear Reactors, Types of reactors, Pressurized water reactors, boiling heater reactors, Heavy water-cooled and moderated (CANDU) reactor, Gas cooled reactors, Liquid metal cooled reactors, Indian Nuclear power installations, comparison between Nuclear and Thermal plants, Numericals.	
UNIT-5	**NON CONVENTIONAL POWER GENERATION**	**07**
	Introduction, Direct energy conversion, MHD, Thermionic and Thermoelectric power generation, Fuel cells, Geothermal energy, Hydrogen energy systems, Numericals.	

TEXT BOOKS

1. Power Plant Engineering, P. K. Nag, Tata McGraw Hill, 4 Edition, 2014.

2. A Text Book of Power Plant Engineering, R. K. Rajput, Laxmi publication, New Delhi, 4 Edition, 2007.

REFERENCE BOOKS

1. Power Plant Engineering, G.R. Nagpal and S.C. Sharma, Khanna Publishers,16 Edition, 2012.

COURSE OUTCOMES: After completion of the course, students will be able to:

CO1: Know the sources of energy, energy generation by coal and the systems needed for its function.

CO2: Learn the layout, Applications and components of Diesel power plants

CO3: Study Hydrology, required flow graphs for calculating the capacity, site selection and different components of hydroelectric power plant

CO4: Explain nuclear materials, principles of energy release and components of reactors and different types of nuclear reactors and nuclear waste disposal

CO5: Study the different nonconventional energy conversion methods for power generation.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	1	1	1	1	1	1	1	1
CO2	3	3	2	1	1	1	1	1	1	1	1	1
CO3	3	3	3	1	1	1	1	1	1	1	1	1
CO4	3	3	2	1	1	1	1	1	1	1	1	1
CO5	3	3	3	1	1	1	1	1	1	1	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										
3. Each full question shall have maximum of 3 sub-divisions.										

ADMISSION YEAR : 2020-21 **ACADEMIC YEAR: 2023-24**
SEMESTER : SEVENTH

COURSE TITLE : COMPUTATIONAL FLUID DYNAMICS (PROFESSIONAL ELECTIVE - 4)		
Sub Code: 18ME745	**No of Credits : L-T-P-SS 03:00:00:00 =03**	**No. of lecture hours/week : 03 Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**Fluid dynamics, Mathematics**	

COURSE OBJECTIVES:

1. To understand the fundamentals of CFD and fluid flow equations in conservation forms.
2. To understand the various methods of solving linear algebraic equations.
3. To know the discretization methods and understand how it can be used in heat conduction problems.
4. To know the equations related to convection and diffusion and understand the methods to solve these equations.
5. To understand the Navier Stokes equations and turbulent modeling.

	CONTENTS	**Hrs**
UNIT-1	**INTRODUCTION TO COMPUTATIONAL FLUID DYNAMICS**	**07**
	Computational Fluid Dynamics: What, When, and Why?, CFD Applications, Experimental investigations, theoretical calculations, advantages and disadvantages of theoretical calculations, Fundamental principles of conservation, Reynolds transport theorem, Conservation of mass, Conservation of momentum, Conservation of Energy equations, Navier-Stokes equation, Time-average equations for turbulent flow, the turbulent kinetic energy equation, the general differential equations, Nature of coordinates : Independent variables, choice of coordinates, one way and two way coordinates.	
UNIT-2	**DISCRETISATION METHODS**	**08**
	The Discretization concept, The structure of Discretization equation, Methods of deriving the Discretization equation: Taylor series formulation, variation formulation, method of Weighted residuals, Control Volume formulations. Illustrative examples, Four basic rules, Numerical problems.	
UNIT-3	**HEAT CONDUCTION**	**08**
	Heat conduction: Steady one dimensional Conduction: The basic Equation, The grid Spacing, The interface conductivity, Non linearity, Source term Linearization, Boundary conditions, Unsteady one dimensional Conduction: the general Discretization equation, Explicit, Crank Nicolson and fully implicit schemes, Two dimensional and three dimensional situation, Over relaxation and Under relaxation Methods. Problems.	
UNIT-4	**CONVECTION AND DIFFUSION**	**08**
	Steady one dimensional Convection and diffusion, the primary derivation, the upwind scheme, the exact solution, The Exponential scheme, The Hybrid scheme,	

	The power law scheme, consequences of various scheme, Discretization equation for Two dimension, details of derivation, final Discretization equation, Discretization equation for Three dimension, one way space coordinates, outflow boundary conditions, False diffusion: common and proper view of False diffusion.	
UNIT-5	**NAVIER STOKES EQUATIONS AND TURBULENT MODELLING**	**08**
	Discretization of the Momentum Equation: Stream Function-Vorticity approach and Primitive variable approach, Staggered grid and Collocated grid, SIMPLE Algorithm, SIMPLER Algorithm, Important features of turbulent flow, Vorticity transport equation, Statistical representation of turbulent flows: Homogeneous turbulence and isotropic turbulence, General Properties of turbulent quantities, Reynolds average Navier stokes (RANS) equation, Closure problem in turbulence: Necessity of turbulence modeling, Different types of turbulence model: Eddy viscosity 2 models, Mixing length model, The κ-ε model, Advantages and disadvantages of κ -ε model	

TEXT BOOKS:

1. **Computational Fluid Dynamics: The Basics with Applications,** John D. Anderson, Jr., McGraw-Hill International Editions, 1995.
2. **Computational Fluid Flow and Heat Transfer,** K. Muralidhar and T.Sundararajan (Editors), 2nd Edition, Narosa Publishing House, 2003.
3. **Introduction to Computational Fluid Dynamics:** H.K. Versteeg and W. Malalasekera, Pearson Education Limited, 2nd Edition, 2007.

REFERENCE BOOKS:

1. **Computational Fluid Methods for Fluid Dynamics**, J.H. Ferziger and M. Peric, Springer (India) Pvt. Ltd., 3rd Edition, 2002.
2. **Introduction to Computational Fluid Dynamics**, Pradip Niyogi, S.K. Chakrabartty, M.K. Laha, Pearson Education, 2011.
3. **Numerical Heat Transfer and Fluid Flow**, Suhas V. Patankar, Hemisphere Publishing Corporation, 1980.

e-LEARNING RESOURCES

Videos, Lecture notes: http://www.nptel.ac.in

COURSE OUTCOME (CO)

After completion of the course, students will be able to:

CO1: Understand the fundamental concepts of computational fluid dynamics and explain Reynolds transport theorem.

CO2: Understand the concept of Discretization and its methods;

CO3: Discretize the heat conduction equations and solve numerical problems.

CO4: Derive the one dimensional steady convection and diffusion equation; Discretize these equations using different methods.

CO5: Discretize the momentum equation and understand the various turbulent models.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	1	1	1	1	1	1	1	1

CO2	3	3	2	1	1	1	1	1	1	1	1	1
CO3	3	3	3	1	1	1	1	1	1	1	1	1
CO4	3	3	2	1	1	1	1	1	1	1	1	1
CO5	3	3	3	1	1	1	1	1	1	1	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										
3. Each full question shall have maximum of 3 sub-divisions.										

ADMISSION YEAR : 2020-21 **ACADEMIC YEAR: 2023-24**
SEMESTER : SEVENTH

COURSE TITLE : DESIGN LABORATORY		
Sub Code: 18MEL76	**No of Credits =01** **L-T-P-SS::0:0:2:0**	**No. of lecture hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**Design of Machine Elements**	

COURSE OBJECTIVES:

1. To expose the students to various experiments to determine natural frequency of longitudinal and torsional vibration system with and without damping.
2. To study the fringe constant of photo elastic material using circular polariscope.
3. To determine centrifugal force, power, effort, range speed sensitiveness of Porter/ Watt /Hartnell Governor and to learn computer based vibration analysis.

UNITS	**CONTENTS**	**Hrs**
UNIT-1	1. Experimental prediction of natural frequency of compound pendulum, prediction of equivalent simple pendulum system. 2. Experimental prediction of natural frequency for longitudinal vibrations of helical springs, and springs in series and parallel with or without damping and Torsional Vibration. 3. Experimental prediction of natural frequencies, and nodal points for single rotor and two-rotor vibratory system, and comparison with theoretical results 4. Experimental and theoretical investigation of whirling of shaft (i.e. . comparison of experimental and theoretical natural frequency and justification of discrepancy between experiment and theory) 5.Determination of Fringe constant of Photo elastic material using (a) Circular disc subjected to diametric compression (b) Pure bending specimen (four point bending).(c) Tensile specimen. 6.Determination of stress concentration using Photo elasticity for simple components like circular disk with circular hole under diametrical compression,	**18**
UNIT-2	1. Determination of centrifugal force, power, effort, range speed sensitiveness of Porter/ Watt /Hartnel Governor. (Only one or more). 2. Determination of Principal Stresses and strains young's modulus in a member to tensile/combined loading using Strain rosettes. 3. Experiments on modal analysis of cantilever beam using frequency response function.	**08**

REFERENCE BOOKS :

1. **Advanced Mechanics of solids**, L. S. Srinath, Tata Mc. Graw Hill, 2003
2. **Theory of Elasticity,** S. P. Timoshenko and J. N Gordier, Mc.Graw Hill International, 3rd edition, 1972
3. **Theory of Elasticity,** Dr. Sadhu Singh, Khanna Publications, 1988
4. **Elasticity, Theory, Applications &Numericals,** Martin H Sadd, Elsevier. 2005
4. **Applied Elasticity,** Seetharamu & Govindaraju, Interline Publishing

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Expose the various experiments to determine natural frequency of longitudinal and torsional vibration system with and without damping.
CO2: Study the fringe constant of photo elastic material using circular polariscope.
CO3: Visualize the stresses developed in an object through photo elasticity implementation of concept of stress concentration in design.
CO4: Determine centrifugal force, power, effort, range speed sensitiveness of Porter/ Watt /Hartnell Governor and to learn computer based vibration analysis.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	2	1	1	2	2	3	3	1	2
CO2	2	3	3	2	1	1	2	2	3	3	1	2
CO3	3	3	3	2	1	1	2	2	3	2	1	2
CO4	3	3	2	2	1	1	2	2	2	2	1	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not												

SCHEME OF EXAMINATION (SEE)					
Sl. No.	**Particulars**	**Max. Marks**	**Break Up of Max. Marks**		
			Write Up	**Conduction of experiment**	**Specimen Calculation, Tabulation of Results and Plotting of Graph if any**
1	**Unit-1: Minor Experiment** (Any ONE from the list of experiments and it is purely individual Experiment) Q1	**15**	05	05	05
2	**Unit-2: Major Experiment** (Any ONE **Experiment** from the list of experiments and it is a Group Experiment) Q2	**25**	05	10	10
3	Viva Voce	**10**	--	--	--
	TOTAL MARKS	**50**	**10**	**25**	**15**

ADMISSION YEAR : 2020-21 **ACADEMIC YEAR: 2023-24**
SEMESTER : SEVENTH

COURSE TITLE : COMPUTER AIDED MODELING AND ANALYSIS LABORATORY		
Sub Code: 18MEL77	**No of Credits =01** **L-T-P-SS::0:0:2:0**	**No. of practical hours/week: 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**Engineering Mathematics, MOM, DME**	

COURSE OBJECTIVES:

1. To be able to understand and handle design problems in systematic manner
2. To gain practical experience in 2D drafting and 3D modeling software systems.
3. To be able to apply CAD in real life applications.
4. 4.To be able to understand meaning and Usefulness of FEM
5. To be able to understand Various software used to solve the practical problems

#	Contents	Hrs
UNIT-1	**A MODELING STRESS AND ANALYSIS USING FEA PACKAGE**	**13**
	a. Analysis of 1D structural members and verification of the same through manual calculation. b. Bars of constant cross section area, tapered cross section area and stepped bar c. Trusses – (Minimum 2 exercises) d. Beams – Simply supported, cantilever, beams with UDL, beams with varying load etc. (Minimum 6 exercises) e. Includes Theoretical problems and Introduction to meshing	
UNIT-2	**STRESS ANALYSIS OF**	**13**
	a) 2D Stress analysis of a rectangular plate subjected different loads b) Determining of stress concentration factor for rectangular plate with circular cut out and square cutout c)Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions(Minimum 4 exercises) d) Dynamic Analysis 1) Fixed – fixed beam for natural frequency determination 2) Bar subjected to forcing function 3) Fixed – fixed beam subjected to forcing function	

REFERENCE BOOKS:

1. A first course in the Finite element method, Daryl L Logan, Thomason, 3rd Ed.
2. Fundaments of FEM, Hutton – McGraw Hill, 2004
3. Finite Element Analysis, George R. Buchanan, Schaum Series.

COURSE OUTCOMES: On completion of the course, student should be able to:
CO1: Do 3D/2D Modelling and assign the material properties of the models.
CO2: Do proper meshing of the modelled component with different meshing techniques, mesh size control and mesh quality check.
CO3: Assign the required boundary condition, loading condition, types of loading and solve.
CO4: To analyze and evaluate the results obtained after analysis.

MAPPING OF COs WITH POS												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	2	2	3	3	2	3	3	0	2
CO2	2	3	3	2	2	1	3	2	3	3	0	2
CO3	3	3	3	2	3	2	3	1	3	2	0	2
CO4	3	3	2	2	3	2	3	1	2	2	0	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

SCHEME OF EXAMINATION (SEE)					
Sl. No.	**Particulars**	**Max. Marks**	**Break Up of Max. Marks**		
			Write Up	**Conduction of experiment / Modelling Analysis**	**Expected Out Putt-Results (Different displacement, BM, Stress, Strain results. Etc. and Plotting deformation diagram, SFD,BMD, Graph if it's required)**
1	**Unit-1: Minor Experiment** (Any ONE from the list of experiments and it is purely individual Experiment) Q1	**20**	05	05	10
2	**Unit-2: Major Experiment** (Any ONE **Experiment** from the list of experiments and it is a Group Experiment) Q2	**20**	05	5	10
3	Viva Voce	**10**	--	--	--
TOTAL MARKS		**50**			

ADMISSION YEAR : 2020-21 **ACADEMIC YEAR: 2023-24**
SEMESTER : SEVENTH

COURSE TITLE : PROJECT WORK PHASE- I		
Sub Code: 18MEP78	**No of Credits =2** **L-T-P-SS:: 0:0:4:0**	**No. of contact hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**

Course objectives:

1. To provide an amicable atmosphere for students to plan
2. To test their learned theory knowledge in an actual working situation
3. To discover the value of work and relish rewards of accomplishment
4. To ensure a professional preparation to the liberal educational goals.

STAGES FOR PROJECT WORK	
Step 1	Formulation of the problem
Step 2	Exhaustive literature survey
Step 3	Methodology
Step 4	Time estimation for completing the project

The Project proposal shall be submitted within 3 weeks from the start of the semester in the prescribed standard format (04 copies) to the HOD, after the certification of the concerned guide and HOD.

Minimum number of students per batch: 02 Maximum number of students per batch: 04

CIE Evaluation: Two seminars shall be conducted at the end of 6 and 10 week of the semester.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Literature review on par with international journal standards

CO2: Literature gap determination and definition of the problem

CO3: Scientific Design / Numerical Analysis / Analytical model and interpret them

CO4: Apply tools / techniques for problem solving and prepare project work

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	1	1	1
CO2	3	3	2	1	2	1	1	1	1	2	1	1
CO3	3	3	2	1	2	1	1	1	1	2	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

SCHEME OF EXAMINATION (CIE)

1. Departments shall constitute a Departmental Project Review Committee (internal guide + faculty) to review the project at the middle of the semester.
2. Internal guide alone shall evaluate the Project Phase I at the end of the semester for a maximum of 35 marks.
3. Project Review Committee shall evaluate the Project Phase I at the end of the semester for a maximum of 15 marks.

SCHEME OF EVALUATION (CIE)			
PARTICULARS	**Guide (MAX MARKS)**	**Project Review Committee (MAX MARKS)**	**Total Marks**
Formulation of the problem		**03**	
Relevance of the subject in the present context		**02**	
Literature Survey		**02**	
Problem formulation		**03**	
Oral presentation		**05**	
TOTAL	**35**	**15**	**50**

SCHEME OF EVALUATION (SEE)	
Sl. No.	**PARTICULARS**
1	Formulation of the problem
2	Relevance of the subject in the present context
3	Literature Survey
4	Problem formulation
5	Oral presentation

GUIDELINES FOR PREPARING PROJECT REPORT

1. Project reports should be typed neatly only on one side of the paper with 1.5 or double line spacing on an A4 size bond paper (210 x 297 mm).
2. **The margins should be:** Left – 1.25″, Right – 1″, Top and Bottom – 0.75″.
3. The total number of reports to be prepared are
   i) A copy to the department library
   ii) A copy to the concerned guide(s)
   iii) Two copies to the sponsoring agency
   iv) Candidate's copy.
4. Before taking the final printout, the approval of the **concerned guide(s) is mandatory** with suggested corrections, if any, to be incorporated.
5. For making copies dry tone Xerox is suggested. Every copy of the report must contain Inner title page (White) Outer title page with a plastic cover Certificate in the format enclosed both from the college and the organization where the project is carried out.
6. An **abstract (synopsis)** not exceeding 100 words, indicating salient features of the work. (NB: four copies of the abstract are to be submitted to the Department on the date of submission separately)
7. The organization of the report should be as follows
   i) Inner title page
   ii) Abstract or Synopsis
   iii) Acknowledgments
   iv) Table of Contents
   v) List of table & figures (optional)
   vi) Usually numbered in roman

vii) Chapters (to be numbered in Arabic) containing Introduction-, which usually specifies the scope of work and its importance and relation to previous work and the present developments, Main body of the report divided appropriately into chapters, sections and subsections.

viii) The chapters, sections and subsections may be numbered in the decimal form for e.g. Chapter 2, sections as 2.1, 2.2 etc., and subsections as 2.2.3, 2.5.1 etc.

ix) The chapter must be left or right justified (font size 16). Followed by the title of chapter centered (font size 18), section/subsection numbers along with their headings must be left justified with section number and its heading in font size 16 and subsection and its heading in font size 14. The body or the text of the report should have font size 12.

x) The figures and tables must be numbered chapter wise for e.g.: Fig. 2.1 Block diagram of a serial binary adder, Table 3.1 Primitive flow table, etc.

xi) The last chapter should contain the summary of the work carried, contributions if any, their utility along with the scope for further work.

xii) **Reference OR Bibliography:** The references should be numbered serially in the order of their occurrence in the text and their numbers should be indicated within square brackets for e.g. [3]. The section on references should list them in serial order in the following format.

For textbooks – A.V. Oppenheim and R.W. Schafer, Digital Signal Processing, Englewood, N.J., Prentice Hall, 3 Edition, 1975.

For papers – Devid, Insulation design to combat pollution problem, Proc of IEEE, PAS, Vol 71, Aug 1981, pp 1901-1907.

8. Only SI units are to be used in the report. Important equations must be numbered in decimal form for e.g.

$$V = IZ \text{ ……. } (3.2)$$

All equation numbers should be right justified.

9. The project report should be brief and include descriptions of work carried out by others only to the minimum extent necessary. Verbatim reproduction of material available elsewhere should be strictly avoided. Where short excerpts from published work are desired to be included, they should be within quotation marks appropriately referenced.

   Proper attention is to be paid not only to the technical contents but also to the organization of the report and clarity of the expression. Due care should be taken to avoid spelling and typing errors. The student should note that report-write-up forms the important component in the overall evaluation of the project

10. Hardware projects must include: the component layout, complete circuit with the component list containing the name of the component, numbers used, etc. and the main component data sheets as Appendix.
11. At the time of report submissions, the students must hand over a copy of these details to the project coordinator and see that they are entered in proper registers maintained in the department.
12. Software projects must include a virus free disc, containing the software developed by them along with the read me file. Read me file should contain the details of the variables used, salient features of the software and procedure of using them: compiling procedure, details of the computer hardware/software requirements to run the same, etc. If the developed software uses any public domain software downloaded from some site, then the address of the site along with the module name etc. must be

included on a separate sheet. It must be properly acknowledged in the acknowledgments.

13. Sponsored Projects must also satisfy the above requirements along with statement of accounts, bills for the same dully attested by the concerned guides to process further, They must also produce NOC from the concerned guide before taking the internal viva examination.
14. The reports submitted to the department/guide(s) must be hard bounded, with a plastic covering.
15. Separator sheets, used if any, between chapters, should be of thin paper

COLOUR OF THE OUTER COVER/FRONT PAGE OF UG DISSERTATION / PROJECT REPORT - SKY BLUE

Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY

(An autonomous institution, Aided by Govt. of Karnataka, Affiliated to VTU)
BDA Outer Ring Road, Near Jnana Bharathi Campus, Bengaluru - 560056

Aided By Govt. of Karnataka

Department of Mechanical Engineering

CERTIFICATE

Certified that the project work - Phase I (Seventh Semester) entitled…… is carried out by the following bonafide students of Mechanical Engineering in partial fulfilment for the award of Bachelor of Engineering, B. E (Mechanical) at **Dr. Ambedkar Institute of Technology, Bangalore,** during the academic year ..... **.**

Sl. No	**U S N** (ascending order)	**Name of Student**

It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the project report.

The project report has been approved satisfying the academic requirements prescribed for the said Degree.

Guide	**Internal Examiner**	**HOD**

ADMISSION YEAR : 2020-21 **ACADEMIC YEAR: 2023-24**
SEMESTER : SEVENTH

COURSE TITLE : INDUSTRY INTERNSHIP	
Sub Code: 18MEI79	**No of Credits =00** **L-T-P-SS::0:0:2:0**

Internship: All the students admitted to III year of BE/B. Tech have to undergo mandatory internship of 4 weeks during the vacations of VI and VII semesters and /or VII and VIII semesters. If not completed after VI semester examinations, it has to be carried out during the intervening vacations of VII and VIII semesters). A University examination will be conducted during VIII semester and prescribed credit are added to VIII semester. Internship is considered as a head of passing and is considered for the award of degree. Those, who do not take-up/complete the internship will be declared as failed and have to complete during subsequent University examination after satisfy the internship requirements.

OBJECTIVE:

1. To inculcate the working procedure in the students in the industry by incorporating their knowledge gained during engineering course.
2. Exposing the student community to the real working environment in the industry.

PROCEDURE FOR INTERNSHIP:

1. Students shall approach any one of small, medium or large scale industries of their choice and get permission for carryout internship for a minimum duration of four weeks.
2. Obtain a permission/recommendation letter from the college to the respective industry to permit him/her to carry out the internship.
3. After obtaining a permission from industry, fix the time period for internship (during their intervening vacations of VII and VIII semester) after mutual discussion with the industry and the students. The same should be communicated to the department regarding the time period of internship.
4. Student should start and continue his/her internship with the assistance and guidance of the allotted authorised person to gain maximum knowledge of real time working in the industry.
5. Student should maintain a fact sheet of working (containing timings, machines, operations, softwares, programmes etc.) on day to day basis for his/her entire period of internship.
6. Obtain a signature in all the fact sheet from the authorised person under whom guidance he/she is working.
7. An internship certificate issued by that industry should be obtained and submitted to the department.
8. Immediately after completion of the internship he/she must prepare an internship report containing internship certificate and submit the report to the department for evaluation.

SCHEME OF EVALUATION (CIE): Internal evaluation will be conducted at the end of the semester by two internal faculty members nominated by the department.

SCHEME OF EVALUATION (CIE)		
DETAILS	**MAXIMUM MARKS**	**Two Internals faculty members**
Internship/ report	**30**	
Presentation	**10**	
Viva Voce	**10**	
Max Marks	**50**	

SCHEME OF EVALUATION (SEE): The viva-voce examination will be conducted by the two examiner's consisting of one internal examiner and another external examiner from industry where student undergone internship. In case, an external examiner is not available, a senior faculty member from the department can be used.

SCHEME OF EVALUATION (SEE)		
DETAILS	**MAXIMUM MARKS**	**Two examiners**
Presentation	**30**	
Viva Voce	**20**	
Max Marks	**50**	

GUIDELINES FOR PREPARING INTERNSHIP REPORT

1. Internship reports should be typed neatly only on one side of the paper with 1.5 or double line spacing on an A4 size bond paper (210 x 297 mm).

2. The margins should be: Left – 1.25″, Right – 1″, Top and Bottom – 0.75″.

3. The total number of reports to be prepared are
   v) A copy to the department library
   vi) A copy to the concerned guide(s)
   vii) Two copies to the industry guide
   viii) Candidate's copy.

4. Before taking the final printout, the approval of the industry and **guide in the college is mandatory** with suggested corrections, if any, to be incorporated.
5. For making copies dry tone Xerox is suggested. Every copy of the report must contain Inner title page (White) Outer title page with a plastic cover Certificate in the format enclosed both from the college and the organization where the project is carried out.
6. An **abstract (synopsis)** not exceeding 100 words, indicating salient features of the internship work. (NB: four copies of the abstract are to be submitted to the Department on the date of submission separately)
7. The organization of the report should be as follows
   i) Inner title page
   ii) Internship completion certificate
   iii) Abstract of internship
   iv) Acknowledgment
   v) Table of Contents
   vi) List of table & figures (optional)
   vii) Usually numbered in roman
   viii) Chapters (to be numbered in Arabic) containing **Introduction-**, which usually specifies the scope of work and its importance and industrial importance, Main body of the report divided appropriately into chapters, sections and subsections.
   ix) The chapters, sections and subsections may be numbered in the decimal form for e.g. Chapter 2, sections as 2.1, 2.2 etc., and subsections as 2.2.3, 2.5.1 etc.
   x) The chapter must be left or right justified (font size 16). Followed by the title of chapter centered (font size 18), section/subsection numbers along with their headings must be left justified with section number and its heading in font size 16 and subsection and its heading in font size 14. The body or the text of the report should have font size 12.
   xi) The figures and tables must be numbered chapter wise for e.g.: Fig. 2.1 Block diagram of a serial binary adder, Table 3.1 Primitive flow table, etc.
   xii) The last chapter should contain the summary of the internship work carried, contributions if any, their utility along with the scope for further work.
   xiii) **Reference OR Bibliography:** The references should be numbered serially in the order of their occurrence in the text and their numbers should be indicated within square brackets for e.g. [3]. The section on references should list them in serial order in the following format.
   For textbooks – A.V. Oppenheim and R.W. Schafer, Digital Signal Processing, Englewood, N.J., Prentice Hall, 3 Edition, 1975.

8. Only SI units are to be used in the report. Important equations must be numbered in decimal form for e.g.

$$V = IZ \quad \text{……. (3.2)}$$

All equation numbers should be right justified.

16. The project report should be brief and include descriptions of internship. Verbatim reproduction of material available elsewhere should be strictly avoided. Where short excerpts from published work are desired to be included, they should be within quotation marks appropriately referenced.
    Proper attention is to be paid not only to the technical contents but also to the organization of the report and clarity of the expression. Due care should be taken to avoid spelling and typing errors. The student should note that report-write-up forms the important component in the overall evaluation of the project
17. Hardware projects must include: the component layout, complete circuit with the component list containing the name of the component, numbers used, etc. and the main component data sheets as Appendix.
18. At the time of report submissions, the students must hand over a copy of these details to the project coordinator and see that they are entered in proper registers maintained in the department.
19. The reports submitted to the department/guide(s) must be hard bounded, with a plastic covering.
20. Separator sheets, used if any, between chapters, should be of thin paper

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Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY

(An autonomous institution, Aided by Govt. of Karnataka, Affiliated to VTU)
BDA Outer Ring Road, Near Jnana Bharathi Campus, Bengaluru - 560056

Department of Mechanical Engineering

CERTIFICATE

Certified that the industry internship (Seventh Semester) entitled…… is carried out by the following bonafide student of Mechanical Engineering in partial fulfilment for the award of Bachelor of Engineering, B. E (Mechanical) at **Dr. Ambedkar Institute of Technology, Bangalore,** during the academic year ..... **.**

U S N	Name of Student

It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the project report.

The internship report has been approved satisfying the academic requirements prescribed for the said Degree.

Guide	**Internal Examiner**	**HOD**

ADMISSION YEAR : 2020-21 **CADEMIC YEAR: 2023-24**
SEMESTER : EIGHTH

COURSE TITLE : PROJECT WORK PHASE – II		
Sub Code: 18MEP81	**No of Credits : 10**	**No. of contact hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**

COURSE OBJECTIVES:

1. To provide an opportunity and atmosphere in which students may test theory learned in the classroom in an actual working situation and discover the value of work and the rewards of accomplishment
2. To insure a natural transition to the higher level of professional preparation as a complement to the liberal education goals of the Institution.

STAGES OF PROJECT WORK
Identification of project topic related to area of interest in the field of advanced or current mechanical engineering
Literature survey based on the identified topic
Define / formulate the problem and the methodology
Design and fabricate or analysis based on type of problem
Results, conclusions, scope for further work
References.
Oral presentation of the project at the end of 6^{th} and 10^{th} week of a semester

OUTCOMES: On completion of the course, student should be able to:

CO1: Perform literature review on par with international journal standards.

CO2: Identify literature gap and define the problem.

CO3: Design experiments scientifically / perform numerical analysis / develop analytical models and interpret the results and apply advanced tools / techniques for solving the problem.

CO4: Prepare quality document of project work.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	1	1	3	3	2	3	1
CO2	3	3	2	3	3	1	1	3	3	2	3	2
CO3	3	3	3	3	3	1	1	3	3	2	3	2
CO4	3	3	2	1	3	1	1	2	2	3	3	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

CIE EVALUATION: Two presentations shall be conducted at the end of 6^{th} and 10^{th} week of the semester. The Project Report shall be submitted in the prescribed standard format (04 copies) to the HOD, after the certification of the concerned guide and HOD.

SCHEME OF EVALUATION (CIE)			
PARTICULARS	**Guide (MAX MARKS)**	**Project Review Committee (MAX MARKS)**	**Total Marks**
Relevance of topic		**05**	
Oral presentation		**05**	
Viva Voce		**05**	
TOTAL	**35**	**15**	**50**

SCHEME OF EVALUATION (SEE)		
Sl. No.	**Particulars**	**Max. Marks**
1	Relevance of the subject in the present context	**05**
2	Literature Survey	**05**
3	Problem formulation	**05**
4	Experimental observation / theoretical modelling	**05**
5	Results – Presentation & Discussion	**05**
6	Conclusions and scope for future work	**05**
7	Overall presentation of the Thesis/Oral presentation	**20**
	Total Marks	**50**

GUIDELINES FOR PREPARING PROJECT REPORT

9. Project reports should be typed neatly only on one side of the paper with 1.5 or double line spacing on an A4 size bond paper (210 x 297 mm).
10. **The margins should be:** Left – 1.25″, Right – 1″, Top and Bottom – 0.75″.
11. The total number of reports to be prepared are
    ix) A copy to the department library
    x) A copy to the concerned guide(s)
    xi) Two copies to the sponsoring agency
    xii) Candidate's copy.
12. Before taking the final printout, the approval of the **concerned guide(s) is mandatory** with suggested corrections, if any, to be incorporated.
13. For making copies dry tone Xerox is suggested. Every copy of the report must contain Inner title page (White) Outer title page with a plastic cover Certificate in the format enclosed both from the college and the organization where the project is carried out.
14. An **abstract (synopsis)** not exceeding 100 words, indicating salient features of the work. (NB: four copies of the abstract are to be submitted to the Department on the date of submission separately)
15. The organization of the report should be as follows
    xiv) Inner title page
    xv) Abstract or Synopsis
    xvi) Acknowledgments
    xvii) Table of Contents
    xviii) List of table & figures (optional)
    xix) Usually numbered in roman
    xx) Chapters (to be numbered in Arabic) containing Introduction-, which usually specifies the scope of work and its importance and relation to previous work and

the present developments, Main body of the report divided appropriately into chapters, sections and subsections.

xxi) The chapters, sections and subsections may be numbered in the decimal form for e.g. Chapter 2, sections as 2.1, 2.2 etc., and subsections as 2.2.3, 2.5.1 etc.

xxii) The chapter must be left or right justified (font size 16). Followed by the title of chapter centered (font size 18), section/subsection numbers along with their headings must be left justified with section number and its heading in font size 16 and subsection and its heading in font size 14. The body or the text of the report should have font size 12.

xxiii) The figures and tables must be numbered chapter wise for e.g.: Fig. 2.1 Block diagram of a serial binary adder, Table 3.1 Primitive flow table, etc.

xxiv) The last chapter should contain the summary of the work carried, contributions if any, their utility along with the scope for further work.

xxv) **Reference OR Bibliography:** The references should be numbered serially in the order of their occurrence in the text and their numbers should be indicated within square brackets for e.g. [3]. The section on references should list them in serial order in the following format.

For textbooks – A.V. Oppenheim and R.W. Schafer, Digital Signal Processing, Englewood, N.J., Prentice Hall, 3 Edition, 1975.

For papers – Devid, Insulation design to combat pollution problem, Proc of IEEE, PAS, Vol 71, Aug 1981, pp 1901-1907.

16. Only SI units are to be used in the report. Important equations must be numbered in decimal form for e.g.

$$V = IZ \text{ ……. } (3.2)$$

All equation numbers should be right justified.

21. The project report should be brief and include descriptions of work carried out by others only to the minimum extent necessary. Verbatim reproduction of material available elsewhere should be strictly avoided. Where short excerpts from published work are desired to be included, they should be within quotation marks appropriately referenced.

    Proper attention is to be paid not only to the technical contents but also to the organization of the report and clarity of the expression. Due care should be taken to avoid spelling and typing errors. The student should note that report-write-up forms the important component in the overall evaluation of the project

22. Hardware projects must include: the component layout, complete circuit with the component list containing the name of the component, numbers used, etc. and the main component data sheets as Appendix.
23. At the time of report submissions, the students must hand over a copy of these details to the project coordinator and see that they are entered in proper registers maintained in the department.
24. Software projects must include a virus free disc, containing the software developed by them along with the read me file. Read me file should contain the details of the variables used, salient features of the software and procedure of using them: compiling procedure, details of the computer hardware/software requirements to run the same, etc. If the developed software uses any public domain software downloaded from some site, then the address of the site along with the module name etc. must be included on a separate sheet. It must be properly acknowledged in the acknowledgments.

25. Sponsored Projects must also satisfy the above requirements along with statement of accounts, bills for the same dully attested by the concerned guides to process further, They must also produce NOC from the concerned guide before taking the internal viva examination.
26. The reports submitted to the department/guide(s) must be hard bounded, with a plastic covering.
27. Separator sheets, used if any, between chapters, should be of thin paper

COLOUR OF THE OUTER COVER/FRONT PAGE OF UG DISSERTATION / PROJECT REPORT - SKY BLUE

Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY

(An autonomous institution, Aided by Govt. of Karnataka, Affiliated to VTU)
BDA Outer Ring Road, Near Jnana Bharathi Campus, Bengaluru - 560056

Aided By Govt. of Karnataka

Department of Mechanical Engineering

CERTIFICATE

Certified that the project work - Phase II (Eighth Semester) entitled…… is carried out by the following bonafide students of Mechanical Engineering in partial fulfilment for the award of Bachelor of Engineering, B. E (Mechanical) at **Dr. Ambedkar Institute of Technology, Bangalore,** during the academic year ..... **.**

Sl. No	**U S N (ascending order)**	**Name of Student**

It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the project report.

The project report has been approved satisfying the academic requirements prescribed for the said Degree.

Guide	**HOD**	**Principal**

External Viva:

Sl. No	Name of the examiner	Signature with date
1		
2		

ADMISSION YEAR : 2020-21 **CADEMIC YEAR: 2023-24**
SEMESTER : EIGHTH

COURSE TITLE : TECHNICAL SEMINAR		
Sub Code: 18MES82	**No of Credits : 02**	**No. of contact hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**

COURSE OBJECTIVES:

1. To equip students for making a technical presentation based on a thorough re-search review on any contemporary area of Engineering and Management fields
2. Offering the student an opportunity to interact with faculty and peer group and to build the ability to making independent presentation.

STAGES OF SUBJECT SEMINAR
Identification of seminar topic related to area of interest in the field of advanced mechanical engineering.
Literature survey on the selected topics and collection of research papers.
Final seminar shall be presented during 8 /9 week of the semester in the department before the Departmental Evaluation Committee constituted by HOD.
The seminar marks are to be awarded by the committee.
Students shall submit the seminar report in the prescribed standard format.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Conduct literature survey on a current topic based on peer reviewed literature and identify research gap in the literature

CO2: Develop methodologies to resolve the identified problem(s)

CO3: Develop presentation slides / report arranging the material coherently and discuss the topic with clarity and confidence.

CO4: Summarize the presentation, submit the report and identify scope for further work.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	2	3	3	3	3	3
CO2	3	3	2	3	3	3	2	3	3	3	3	3
CO3	3	3	3	3	3	3	2	3	3	3	3	3
CO4	3	3	2	1	3	3	3	3	3	3	3	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

SCHEME OF EVALUATION (CIE)			
PARTICULARS	**Guide (MAX MARKS)**	**Project Review Committee (MAX MARKS)**	**Total Marks**
Relevance of topic		**05**	
Oral presentation		**10**	
Viva Voce		**10**	
TOTAL	**25**	**25**	**50**

SCHEME OF EVALUATION (SEE)		
Sl. No.	**Particulars**	**Max. Marks**
1	Relevance of the subject in the present context	**05**
2	Literature Survey	**05**
3	Problem formulation	**05**
4	Experimental observation / theoretical modelling	**05**
5	Results – Presentation & Discussion	**05**
6	Conclusions and scope for future work	**05**
7	Overall presentation	**20**
	Total Marks	**50**

ADMISSION YEAR : 2020-21 **CADEMIC YEAR: 2023-24**
SEMESTER : EIGHTH

COURSE TITLE : INDUSTRY INTERNSHIP		
Sub Code: 18MEI83	**No of Credits : 02**	**No. of contact hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**

Internship: All the students admitted to III year of BE/B. Tech have to undergo mandatory internship of 4 weeks during the vacations of VI and VII semesters and /or VII and VIII semesters. If not completed after VI semester examinations, it has to be carried out during the intervening vacations of VII and VIII semesters). A University examination will be conducted during VIII semester and prescribed credit are added to VIII semester. Internship is considered as a head of passing and is considered for the award of degree. Those, who do not take-up/complete the internship will be declared as failed and have to complete during subsequent University examination after satisfy the internship requirements.

OBJECTIVE:

1. To inculcate the working procedure in the students in the industry by incorporating their knowledge gained during engineering course.
2. Exposing the student community to the real working environment in the industry.

PROCEDURE FOR INTERNSHIP:

1. Students shall approach any one of small, medium or large scale industries of their choice and get permission for carryout internship for a minimum duration of four weeks.
2. Obtain a permission/recommendation letter from the college to the respective industry to permit him/her to carry out the internship.
3. After obtaining a permission from industry, fix the time period for internship (during their intervening vacations of VII and VIII semester) after mutual discussion with the industry and the students. The same should be communicated to the department regarding the time period of internship.
4. Student should start and continue his/her internship with the assistance and guidance of the allotted authorised person to gain maximum knowledge of real time working in the industry.
5. Student should maintain a fact sheet of working (containing timings, machines, operations, softwares, programmes etc.) on day to day basis for his/her entire period of internship.
6. Obtain a signature in all the fact sheet from the authorised person under whom guidance he/she is working.
7. An internship certificate issued by that industry should be obtained and submitted to the department.
8. Immediately after completion of the internship he/she must prepare an internship report containing internship certificate and submit the report to the department for evaluation.

SCHEME OF EVALUATION (CIE): Internal evaluation will be conducted at the end of the semester by two internal faculty members nominated by the department.

SCHEME OF EVALUATION (CIE)		
DETAILS	**MAXIMUM MARKS**	**Two Internals faculty members**
Internship/ report	**30**	
Presentation	**10**	
Viva Voce	**10**	
Max Marks	**50**	

SCHEME OF EVALUATION (SEE): The viva-voce examination will be conducted by the two examiner's consisting of one internal examiner and another external examiner from industry where student undergone internship. In case, an external examiner is not available, a senior faculty member from the department can be used.

SCHEME OF EVALUATION (SEE)		
DETAILS	**MAXIMUM MARKS**	**Two examiners**
Presentation	**30**	
Viva Voce	**20**	
Max Marks	**50**	

Dr. Ambedkar Institute of Technology, Bengaluru-560 056
SCHEME OF TEACHING AND EXAMINATION from Academic Year 2023-24
B.E MECHANICAL ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

VII SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical / Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	MC	18HS71	OSHA	CV	2	--	--	03	50	50	100	2
2	PC	18ME71	Control Engineering	ME	4	--	--	03	50	50	100	4
3	PC	18ME72	Operations Research	ME	4	--	--	03	50	50	100	4
4	PE	18ME73X	Professional Elective -3	ME	3	--	--	03	50	50	100	3
5	PE	18ME74X	Professional Elective -4	ME	3	--	--	03	50	50	100	3
6	OE	18XX75X	Open Elective - C		3	--	--	03	50	50	100	3
7	PC	18MEL76	Design Laboratory	ME	--	--	2	03	50	50	100	1
8	PC	18MEL77	Computer Aided Modelling and Analysis Laboratory	ME	--	--	2	03	50	50	100	1
9	Project	18MEP78	Project Work Phase - 1	ME	--	--	2	03	50	50	100	2

10	INT	18MEI79	Internship	(If not completed after VI semester examinations, it has to be carried out during the intervening vacations of VII and VIII semesters)				--	--	--	--	--
				TOTAL	**19**	**--**	**6**	**27**	**450**	**450**	**900**	**23**

Note: PC: Professional core, PE: Professional Elective, OE: Open Elective, INT: Internship, MC: Mandatory Course

Internship: All the students admitted to III year of BE/B.Tech have to undergo mandatory internship of 4 weeks during the vacations of VI and VII semesters and /or VII and VIII semesters. A University examination will be conducted during VIII semester and prescribed credit are added to VIII semester. Internship is considered as a head of passing and is considered for the award of degree. Those, who do not take-up/complete the internship will be declared as failed and have to complete during subsequent University examination after satisfy the internship requirements.

Course code	**Professional Electives - 3**	Open Elective - C
18ME731	Computer Integrated Manufacturing	Students can select any one of the open electives (Please refer to consolidated list of Dr AIT for open electives) offered by any Department. Selection of an open elective is not allowed provided, • The candidate has studied the same course during the previous semesters of the programme. • The syllabus content of open elective is similar to that of Departmental core courses or professional electives. • A similar course, under any category, is prescribed in the higher semesters of the programme. Registration to electives shall be documented under the guidance of Programme Coordinator / Mentor.
18ME732	Rapid Prototyping	
18ME733	Project Management	
18ME734	Solar Thermal Engineering	
18ME735	Mechanics Of Viscoelastic Materials	
Course code	**Professional Electives - 4**	
18ME741	Smart Materials	
18ME742	High Entropy Materials	
18ME743	Tribology and Bearing Design	
18ME744	Power Plant Engineering	
18ME745	Computational Fluid Dynamics	
	OPEN ELECTIVE – B	
18XX75X		

Dr. Ambedkar Institute of Technology, Bengaluru-560 056
SCHEME OF TEACHING AND EXAMINATION from Academic Year 2023-24
B.E MECHANICAL ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

VIII SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	MC	18HS81	CMEP	IM	4	--	--	03	50	50	100	2
2	Project	18MEP81	Project Work Phase - 2	ME	--	--	2	03	50	50	100	10
3	Seminar	18MES82	Technical Seminar		--	--	2	03	50	50	100	1
4	INT	18MEI83	Internship	(Completed during the intervening vacations of VI and VII semesters and /or VII and VIII semesters.)				03	50	50	100	2
				TOTAL	**04**	**--**	**04**	**12**	**200**	**200**	**400**	**15**

Note: PC: Professional Core, PE: Professional Elective, OE: Open Elective, INT: Internship, MC: Mandatory Course

Electives

Internship: Those, who have not pursued /completed the internship will be declared as failed and have to complete during subsequent SEE examination after they satisfy the internship requirements.

CMEP: Cost Management of Engineering Projects, OSHA: Occupational Safety and Health Administration

OPEN ELECTIVE COURSES-I (SIXTH SEMESTER)		
Course code	**Subjects**	**Credits**
21MET6051	Operations Research	3
21MET6052	Energy and Environment Engineering	3
21MET6053	Engineering Economics	3
21MET6054	Product Design And Development	3

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2023-24
SEMESTER : SIXTH

Course Title	**OPERATIONS RESEARCH (OPEN ELECTIVE COURSES – I)**	
Sub.Code:**21MET6051**	No. of Credits:**03 = 3:0:0 (L-T-P)**	No. of Lecture Hours/Week**:03**
Exam Duration: **03** Hrs.	**Max. Marks Assigned:** CIE+Asmt+GA+SEE=**40+5+5+50=100**	Total No.of Contact Hours:**40**
Category	**OEC**	
Pre-requisites	**Engineering Mathematics**	

COURSE OBJECTIVES:

1. Impart knowledge of mathematics, basic and applied sciences.
2. Ability to identify, formulate and solve mechanical engineering problems based on data interpretation, design, experiment and analysis of results.
3. Learn effective engineering communication.
4. Ability to work in teams on multi-disciplinary projects in industry and research organizations.
5. Develop awareness of the ethical, professional and environmental implications of work in a global and societal context.

#	CONTENTS	Hrs.
UNIT-1	**INTRODUCTION & SOLUTION OF LINEAR PROGRAMMING PROBLEMS**	**08**
	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-canonical and standard forms of an LP problem, slack, surplus and artificial variables (Numerical problems).	
UNIT-2	**TRANSPORTATION PROBLEM**	**08**
	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, maximization cases (online)	
UNIT-3	**ASSIGNMENT PROBLEM & SEQUENCING**	**08**
	Assignment Problem-formulation balanced and unbalanced types, application to maximization cases and travelling salesman problem (Numericals). Basic assumptions, sequencing using Johnson's algorithm, 'n' jobs 2 machines, 'n' jobs 3 machines, 'n' jobs 'm' machines without passing sequence, graphical solutions. **.:**	
UNIT-4	**PERT-CPM TECHNIQUES**	**08**

	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.	
UNIT-5	**GAME THEORY & REPLACEMENT**	**08**
	Formulation of games, types, solution of games with saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games. Replacement items deteriorating with time, when money value remains same Replacement of items which fail suddenly; Individual replacement policy, Group replacement policy.	

TEXT BOOKS

1. Operations Research, P K Gupta and D S Hira, Chand Publications, New Delhi - 2007
2. Operations Research, Taha H A, Pearson Education

REFERENCE BOOKS

1. Operations Research, A P Verma, S K Kataria & Sons, 2008
2. Operations Research, Paneerselvan, PHI
3. Operations Research, A M Natarajan, P Balasubramani, Pearson Education, 2005
4. Introduction to Operations Research, Hiller and Liberman, McGraw Hill.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Define models for linear programming and convert the linear variable problems to a mathematical model and depict by graphical method.

CO2: Compute the minimum cost of transportation by NWCR, LCM and VAM method and then to find optimum solution by MODI method.

CO3: Find optimal assignment by Hungarian method.

CO4: Design a project network diagram and schedule the project activities and duration using PERT and CPM.

CO5: Illustrate the strategies of different players in a game and find the best strategy by graphical and dominance method.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	1	2	0	1	0	2	1	3	2	2
CO2	3	3	1	2	1	1	0	2	1	3	2	2
CO3	3	3	1	2	1	1	0	2	1	3	2	2
CO4	3	3	1	2	3	1	0	2	2	3	3	3
CO5	3	3	1	2	3	1	1	3	3	3	3	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										

2. Student shall answer five full questions selecting one full question from each unit.

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2023-24
SEMESTER : SIXTH

Course Title	**ENERGY AND ENVIRONMENTAL ENGINEERING (OPEN ELECTIVE COURSE – I)**	
Sub.Code:**21MET6052**	No. of Credits:**03 = 3:0:0 (L-T-P)**	No. of Lecture Hours/Week**:03**
Exam Duration: **03** Hrs.	**Max. Marks Assigned:** CIE+Asmt+GA+SEE=**40+5+5+50=100**	Total No.of Contact Hours:**40**
Category	**OEC**	
Pre-requisites	**Elements of Mechanical Engineering**	

COURSE OBJECTIVES:

1. To understand the fundamentals of energy resources, energy systems, energy efficiency and energy storage.
2. To understand the ecosystem and energy flow in ecosystem.
3. To understand Biodiversity, Conservation, threats to biodiversity and endemic species.
4. To introduce various aspects of environmental pollution and its control.
5. To understand the causes and remedies related to social issues like global warming, ozone layer depletion, climate change etc.

#	CONTENTS	Hrs.
UNIT-1	Introduction to Energy Science	**08**
	Introduction to energy systems and resources; Introduction to Energy, sustainability & the environment; Overview of energy systems, sources, transformations, efficiency, and storage; Fossil fuels (coal, oil, oil-bearing shale and sands, coal gasification) - past, present & future, Remedies & alternatives for fossil fuels - biomass, wind, solar, nuclear, wave, tidal and hydrogen; Sustainability and environmental trade-offs of different energy systems; possibilities for energy storage or regeneration (Ex. Pumped storage hydro power projects, superconductor-based energy storages, high efficiency batteries)	
UNIT-2	Ecosystems	**08**
	Concept of an ecosystem; Structure and function of an ecosystem; Producers, consumers and decomposers; Energy flow in the ecosystem; Ecological succession; Food chains, food webs and ecological pyramids; Introduction, types, characteristic features, structure and function of the following ecosystem (a.)Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	
UNIT-3	Biodiversity and its conservation	**08**
	Introduction – Definition: genetic, species and ecosystem diversity; Bio-geographical classification of India; Value of biodiversity: consumptive use, productive use, social,	

	ethical, aesthetic and option values; Biodiversity at global, National and local levels; India as a mega-diversity nation; Hot-sports of biodiversity; Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; Endangered and endemic species of India; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.	
UNIT-4	Environmental Pollution	**08**
	Definition, Cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards; Solid waste Management: Causes, effects and control measures of urban and industrial wastes; Role of an individual in prevention of pollution; Pollution case studies; Disaster management: floods, earthquake, cyclone and landslides	
UNIT-5	Social Issues and the Environment	**08**
	From Unsustainable to Sustainable development; Urban problems related to energy; Water conservation, rain water harvesting, watershed management; Resettlement and rehabilitation of people; its problems and concerns. Case Studies Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies Wasteland reclamation; Consumerism and waste products; Environment Protection Act; Air (Prevention and Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; Issues involved in enforcement of environmental legislation; Public awareness.	

GROUP ASSIGNMENTS:

Assignments related to e-waste management; Municipal solid waste management; Air pollution control systems; Water treatment systems; Wastewater treatment plants; Solar heating systems; Solar power plants; Thermal power plants; Hydroelectric power plants; Biofuels; Environmental status assessments; Energy status assessments etc.

TEXT BOOKS

1. Textbook for Environmental Studies for Undergraduate Courses, Erach Bharucha, University Grants Commission (UGC), January 2013.
2. Energy Management Audit & Conservation, De Barun Kumar, Vrinda Publications, 2007.

REFERENCE BOOKS

1. Energy Management Hand book, W.C. Turner and S. Doty, Fairmont Press, 7th Edition, 2009.
2. Energy Management, W.R. Murphy and G. McKay, Elsevier India, 2003.

COURSE OUTCOME (CO): After completion of the course, students will be able to:

CO1: Understand energy scenario, energy sources and their utilization.

CO2: Understand various methods of energy storage, energy management and economic analysis.

CO3: Analyse the awareness about environment and eco system.

CO4: Understand the environmental pollution and its management along with some case studies.

CO5: Analyse the social issues related to environmental changes and understand the various environmental protection and conservation Acts.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	0	0	0	2	1	1	1	0	1
CO2	3	3	2	0	0	0	2	1	1	1	0	1
CO3	3	3	3	0	0	0	2	1	1	1	0	1
CO4	3	3	3	0	0	0	2	1	1	1	0	1
CO5	3	3	3	0	0	0	2	1	1	1	0	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2023-24
SEMESTER : SIXTH

Course Title	**ENGINEERING ECONOMICS (OPEN ELECTIVE COURSE – I)**	
Sub.Code:**21MET6053**	No. of Credits:**03 = 3:0:0 (L-T-P)**	No. of Lecture Hours/Week**:03**
Exam Duration: **03** Hrs.	**Max. Marks Assigned:** CIE+Asmt+GA+SEE=**40+5+5+50=100**	Total No.of Contact Hours:**40**
Category	**OEC**	
Pre-requisites	**Engineering Mathematics**	

COURSE OBJECTIVES:

1. Helping decision making
2. Calculation of interest
3. Arriving at break-even point
4. Feasibility study from economic point of view
5. Preparation of budget
6. Understanding financial statements
7. Arriving at the product cost.

UNIT	CONTENTS	Hrs.
UNIT-1	**INTRODUCTION**	**08**
	Elements of engineering economics, engineering decision- makers, engineering and economics, problem solving and decision making, intuition and analysis, tactics and strategy. Engineering economic decision, maze. Law of demand and supply, law of returns, interest and interest factors: interest rate, simple interest, compound interest, cash - flow diagrams, personal loans and EMI payment, exercises and discussion.	
UNIT-2	**PRESENT-WORTH COMPARISONS**	**08**
	Conditions for present worth comparisons, basic present worth comparisons, present-worth equivalence, net present-worth, assets with unequal lives, infinite lives, future-worth comparison, pay-back comparison, exercises, discussions and problems.	
UNIT-3	**RATE-OF-RETURN CALCULATIONS AND DEPRECIATION**	**08**
	Rate of return, minimum acceptable rate of return, IRR, IRR misconceptions, cost of capital concepts. Causes of depreciation, basic methods of computing depreciation charges, tax concepts, and corporate income tax.	
UNIT-4	**INTRODUCTION, SCOPE OF FINANCE, FINANCE FUNCTIONS**	**08**
	Statements of financial information: introduction, source of financial information, financial statements, balance sheet, profit and loss account,	

	relation between balance sheet and profit and loss account. Simple Numericals.	
UNIT-5	**FINANCIAL AND PROFIT PLANNING**	**09**
	Introduction, financial planning, profit planning, objectives of profit planning, essentials of profit planning, budget administration, type of budgets, preparation of budgets, advantages, problems and dangers of budgeting. Introduction to bench marking of manufacturing operation. **ESTIMATING AND COSTING:** Components of costs such as direct material costs, direct labor costs, fixed over-heads, factory cost, administrative overheads, first cost, marginal cost, selling price, estimation for simple components.	

TEXT BOOKS:

1. Engineering Economy, Riggs J.L., McGraw Hill, 2002
2. Engineering Economy, Thuesen H.G. PHI , 2002

REFERENCE BOOKS:

1. Engineering Economy, Tarachand, 2000.
2. Industrial Engineering and Management, OP Khanna, Dhanpat Rai & Sons. 2000
3. Financial Management, Prasanna Chandra, TMH, 2004
4. Financial Management, IM PANDEY, Vikas Publisahing House, 2002

COURSE OUTCOMES: At the end of the course the student will be able to:

CO1: Take the right financial decision.
CO2: Help in calculating the financial factors.
CO3: Arrive at feasibility study of the project.
CO4: Training the students for preparing the budget.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	3	1	1	1	2	1	1	1	2
CO3	3	3	3	2	2	1	1	1	2	1	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2023-24
SEMESTER : SIXTH

Course Title	**PRODUCT DESIGN & DEVELOPMENT (OPEN ELECTIVE COURSE – I)**	
Sub.Code:**21MET6054**	No. of Credits:**03 = 3:0:0 (L-T-P)**	No. of Lecture Hours/Week**:03**
Exam Duration: **03** Hrs.	**Max. Marks Assigned:** CIE+Asmt+GA+SEE=**40+5+5+50=100**	Total No.of Contact Hours:**40**
Category	**OEC**	
Pre-requisites	**CAED**	

COURSE OBJECTIVES:

1. Blends the perspectives of marketing, design and manufacturing into single approach to product development.
2. Provide a set of product development methods that can be put into immediate practice on developments projects.
3. Methods provide a concrete approach to solving a product development problem effectively.
4. Ability to work in teams on multi-disciplinary projects in industry and research organizations.
5. Seeds for the creation of their own development methods, uniquely suited for their personalities, talents and company environments

#	CONTENTS	Hrs.
UNIT-1	**INTRODUCTION**	**08**
	Characteristics of successful product development, who designs and develops products? Duration and cost of product development, The challenges of product development. **Development process and organizations:** A generic development process, Concept development: the front end process, Adapting the generic product development process, Product development process flows and product development organizations.	
UNIT-2	**PRODUCT PLANNING**	**07**
	The product planning process, identify opportunities, Evaluate and prioritize projects, allocate resources and plan timing, Complete pre-project planning, Reflect on the results and the process. **Identifying customer needs**: gather raw data from customers, Interpret the raw data in terms of customer needs, Organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process. **Product Specifications:** What are specifications? When are specifications established? Establishing target specifications and setting the final specifications.	
UNIT-3	**CONCEPT GENERATION**	**07**

	The activity of concept generation, Clarify the problem, Search externally, search internally, explore systematically, reflect on the solutions and the process. **Product Architecture:** What is product architecture? Implications of the architecture, establishing the architecture, Platform planning and Related system level design issues. **Industrial Design :** What is industrial design?, Assessing the need for industrial design, The impact of industrial design, The industrial design process, Management of industrial design process and assessing the quality of industrial design.	
UNIT-4	**DESIGN FOR MANUFACTURING**	**09**
	Overview of the DFM process, estimate the manufacturing costs, reduce the costs of components, assembly, supporting production, and impact of DFM decisions on other factors. **Prototyping:** Prototyping basics, principles of prototyping, technologies and planning for prototypes. **Robust Design:** What is Robust Design? , design of experiments and the robust design process.	
UNIT-5	**PATENTS AND INTELLECTUAL PROPERTY**	**09**
	What is intellectual Property? Overview of Patents, Utility Patents, Preparing a Disclosure and its steps **Product development economics:** Elements of economic analysis, base case financial mode, sensitive analysis, project trade – offs, influence of qualitative factors on project success and qualitative analysis. **Managing Projects**: Understanding and representing task, base line project planning, accelerating projects, project execution and postmortem project evaluation.	

TEXT BOOKS:

1. Karl. T. Ulrich, Steven D Eppinger, Anita Goyal, Product Design and Development, Tata McGraw Hill Edition 2009

REFERENCES:

1. Kevin Otto, Kristin Wood Product Design, pearson Education in South Asia.
2. Timjones, Butterworth Heinmann, New Product Development, Oxford, UCI, 1997.
3. GeofferyBoothoyd, peter Dewhurst and Winston Knight, Product Design for Manufacture.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Understand the characteristics of product development and challenges; concept development processes and different types of organisations.

CO2: Prepare Plan for new product development based on the opportunities & allocation of Resources identification of customer needs and specification of product.

CO3: Generate the concept for the new product and establish the product architecture. Fulfil the aesthetic and ergonomic needs based on industrial design concept.

CO4: Estimation of product cost based on DFM concepts & prepares the prototype of new product.

CO5: Economic analysis of the product to manage different product development projects.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	3	1	1	1	2	1	1	1	2
CO3	3	3	3	2	2	1	1	1	2	1	1	1

CO4	3	3	3	1	2	1	1	1	1	2	1	2
CO5	3	3	2	2	1	1	1	1	2	1	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR: 2021-22 ACADEMIC YEAR: 2023-24
SEMESTER : FIFTH

Course Title	**DESIGN OF MACHINE ELEMENTS**	
Sub.Code:**21MET501**	No. of Credits:**3 = 3:0:0 (L-T-P)**	No. of Lecture Hours/Week:**03**
Exam Duration: **03** Hrs.	**Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100**	**Total No of Contact Hours: 40**
Category	**PCC**	
Pre-requisites	**Mechanics of Materials, Material Science and Metallurgy**	

COURSE OBJECTIVES:

1. To familiarize the various steps involved in the Design Process.
2. To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
3. To learn to use standard practices and standard data.
4. To learn to use catalogues and standard machine components.

	CONTENTS	**Hrs**
UNIT-1	**STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS**	**08**
	Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading – curved beams – crane hook and 'C' frame - Factor of safety - theories of failure – Design based on strength and stiffness –Concepts of reliability based design - stress concentration – Design for finite and infinite life under variable loading.	
UNIT -	**ENERGY STORING ELEMENTS AND ENGINE COMPONENTS**	**08**
	SPRINGS: Introduction, classification of springs, stresses in helical coil springs of circular sections, deflection equation, and energy stored in springs and problems on helical coil springs, buffer springs, concentric springs- advantages, applications and design of concentric springs, springs under fluctuating loads. Leaf Springs, advantages and applications, nipping, stresses in leaf springs, semi elliptical leaf spring. Numerical, Design of Engines Components Connecting Rods and crank shafts.	
UNIT -	**TEMPORARY AND PERMANENT JOINTS**	**08**

	PRESSURE VESSELS: Introduction, Purpose, and Unfired Pressure Vessels at Hydroelectric Facilities, Inspection of Unfired Pressure Vessels, Frequency of Inspections, Inspector qualifications, Pre-Inspection Activities, Inspection Procedure, External Inspection, Thickness Survey, Stress Analysis, Internal Inspection, Non Destructive Testing, and Pressure Testing. theory of bonded joints **RIVETED JOINTS**: Types, rivet materials, Modes of failures of riveted joints, Strength Equations – efficiency of riveted joints, Joint Efficiency, Boiler Joints, Lozenge Joints, Riveted Brackets, Eccentrically riveted joints and Numerical problems. **WELDED JOINTS:** Types, Strength of butt and fillet welds, eccentrically loaded welded joints and Numerical problems.	
UNIT- 4	**DESIGN OF GEARS**	**08**
	Design of Gears: Basic details of gears, classification of gears, Lewis equation, form factor, Introduction to Spur, Helical, Bevel and Worm Gears, Speed ratios and number of teeth-Force analysis -Tooth loads – Dynamic, Wear effects, Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces for helical gears.	
UNIT- 5	**BEARINGS**	**08**
	Introduction to Lubricant theories, Angular contact ball bearings., Sliding contact and rolling contact bearings -Hydrodynamic journal bearings, Petroff's Equations, McKee's Eqn., Summerfield Number, Raimondi & Boyd graphs, -- Design of Journal bearings, Selection of ball and roller ,Seals and Gaskets	

TEXT BOOKS:

1. Joseph Shigley,Charles Mischke,Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 8th Edition, Tata McGraw-Hill, 2008.
2. Bhandari V, "Design of Machine Elements", 3rd Edition, Tata McGraw-Hill Book Co, 2010.

DESIGN DATA HANDBOOK:

1. Design Data Hand Book, K. Lingaiah, McGraw Hill, 2nd Ed.
2. Data Hand Book, K. Mahadevan and Balaveera Reddy, CBS Publication

REFERENCE BOOKS:

1. Machine Design**,** Robert L. Norton, Pearson Education Asia, 2001.
2. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design",4th Edition, Wiley, 2005
3. Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", Tata McGraw-Hill Book Co.(Schaum's Outline), 2010
4. Design of Machine Elements, M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V. Venkatesh, Pearson Education, 2006.
5. Machine Design, Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, TMH, New Delhi, Special Indian Edition, 2008.
6. Fundamentals of Machine Component Design, Robert C. Juvinall and Kurt M Marshek, Wiley India Pvt. Ltd., New Delhi, 3rd Edition, 2007.
7. Fundamentals of Machine Elements - Hawrock, Jacobson Mcgraw Hill
8. Machine Design - Patel, Pandya, Sikh, Vol. - I & II, C.
9. Fundamentals of MachineElements B.J. Hamrock, and S.R. Schmid TMH.
10. The Mechanical Design Process. D.G. Ullman, TMH, New Delhi, 2008.

Note: (Use of Lingaiah Design Data Book is permitted in the University examination)

COURSE OUTCOMES: On completion of the course, students will be able to:
CO1: Demonstrate understanding of various design considerations
CO2: Apply basic principles of machine design
CO3: Design machine elements on the basis of strength concept
CO4: Use design data books and various standard codes of practices and acquire skill in preparing production drawings pertaining to various designs.
CO5: Upon completion of this course, the students can able to successfully design machine Components for suitable applications.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	3	1	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3
CO5	3	3	3	3	2	2	3	2	3	1	3	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										
3.Design Data Hand Book is permitted										

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2023-24
SEMESTER : FIFTH

Course Title	**FINITE ELEMENT METHODS & ANALYSIS**	
Sub.Code:**21MET502**	No. of Credits:**04 = 3:0:1 (L-T-P)**	No. of Lecture Hours/Week:**03** No. of Practical hours/week :**02**
Exam Duration: **03** Hrs.	**Max. Marks : CIE+ SEE=40+5+5+50=100**	**Total No of Contact Hours: 40 + 10 Lab Slots**
Category	**IPCC**	
Pre-requisites	**Engineering Mathematics, MOM, DOM**	

COURSE OBJECTIVES:

1. To learn basic principles of finite element analysis procedure and understand design problems in systematic manner
2. To impart structures analysis for stress, strain & dynamic loading knowledge and gain particle experience in 2D drafting
3. To enable formulation of the dimensional structure, mechanical and thermal problems into FEA and able to apply in real life applications.
4. To comprehend the basic concepts and enhance capabilities for solving 2 complex Problems.
5. To introduce the concepts of elastic and static analysis problems and understand various software used to solve the practical problems

#	CONTENTS	Hrs.
UNIT-1	**INTRODUCTION**	**8L+2P**
	Equilibrium equations in elasticity subjected to body force, traction forces, and stress-strain relations for plane stress and plane strains. General description of Finite Element Method, Application and limitations. Types of elements, Node numbering, Half band width, Definitions of FEA and FDM. **BASIC PROCEDURE**: Euler - Langrange equation for bar, beam (cantilever / simply supported fixed), principle of minimum potential energy, Raleigh's Ritz method. Direct approach for stiffness matrix formulation of bar element. Galerkin's method boundary conditions and general comments.	
UNIT-2	**INTERPOLATION MODELS**	**8L+2P**
	Interpolation polynomials- Linear, quadratic and cubic. Simplex complex and multiplex elements.2D PASCAL's triangle. CST elements-Shape functions and Nodal load vector, Strain displacement matrix. **SOLUTION OF 1-DIMENSIONAL BARS:** Solutions of bars and stepped bars for displacements, reactions and stresses by using penalty approach and elimination approach. Guass-elimination technique. Applications.	
UNIT-3	**HIGHER ORDER ELEMENTS**	**8L+2P**
	Lagrange's interpolation, Higher order one dimensional elements-Quadratic and cubic element and their shape functions. Shape function of 2-D quadrilateral element-linear, quadric element Iso-parametric, Sub parametric and Super parametric elements.	
UNIT-4	**TRUSSES & BEAMS**	**8L+2P**
	2D truss Elements Stiffness matrix of Truss element. Examples illustrating how to obtain various internal force diagrams for different types of structural member like trusses Numerical problems. Governing Differentia Equation for beam	

	bending Hermite shape functions for beam element, Derivation of stiffness matrix. Numerical problems of beams carrying concentrated, UDL and linearly varying loads.	
UNIT-5	**STEADY STATE HEAT TRANSFER**	**8L+2P**
	One Dimensional Heat Conduction – Governing Equation – Boundary Condition. Temperature Gradient & B matrix functional approach to Heat Conduction – Element Conductivity Matrix. Assembly & Boundary Conditions, Heat Flux Boundary Conditions, Forced and Natural Boundary Conditions – Numerical problems. Simple Problems.	

#	**Computer Aided Modelling and Analysis (CAMA) LABORATORY**	**Hrs.**
		24
	1. Analysis of 1D structural members and verification of the same through manual calculation. 2. Bars of constant cross section area, tapered cross section area and stepped bar 3. Trusses – (Minimum 2 exercises) 4. Beams – Simply supported, cantilever, beams with UDL, beams with varying load etc. (Minimum 6 exercises) 5. Includes Theoretical problems and Introduction to meshing 6. 2D Stress analysis of a rectangular plate subjected different loads 7. Determining of stress concentration factor for rectangular plate with circular cut out and square cutout 8. Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions(Minimum 4 exercises) 9. Dynamic Analysis a. Fixed – fixed beam for natural frequency determination b. Bar subjected to forcing function c. Fixed – fixed beam subjected to forcing function	

TEXT BOOKS:

1 Finite Elements in Engineering, T.R.Chandrupatla, A.D Belegunde, 3rd Ed PHI.

2. Finite Element Method in Engineering, S.S. Rao, 4th Edition, Elsevier, 2006.

REFERENCE BOOKS:

1. "Finite Element Methods for Engineers" U.S. Dixit, Cengage Learning, 2009.
2. Concepts and applications of Finite Element Analysis, R.D. Cook D.S Maltus, M.E Plesha, R.J.Witt, Wiley 4th Ed, 2009
3. Finite Element Methods, Daryl. L. Logon, Thomson Learning 3rd edition, 2001.
4. Finite Element Method, J.N. Reddy, McGraw -Hill International Edition.

COURSE OUTCOMES: on completion of the course, student should be able to:

CO1: Understand the fundamental concepts of FEM and develop an ability to generate the governing FE equations for systems governed by partial differential Equations.
CO2: Understand the concept of interpolation function and analysis of Bar elements and using software able to do 3D/2D part Modelling
CO3: To imbibe the concept of shape functions of higher order elements of the models with different meshing techniques, mesh size and quality check.
CO4: Understand to analyze the structural applications of trusses and beams subjected to different loading conditions and assign the required boundary condition, loading condition, types of loading and solve
CO5: Obtain the ability to understand heat conduction, heat flux and apply the boundary conditions with analysis to solve numerical problems and to validate results with theoretical and experimental values.

Assessment Details both (CIE and SEE)
The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass. **CIE:** The CIE has two components – CIE - theory component and CIE – laboratory component. Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE. Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.

CONTINUOUS INTERNAL EVALUATION (CIE)		**Max Marks**	**Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually)**	
Theory	**Weightage of CIE1 and CIE2 Tests or CIE3**	**30**	**12**	
Laboratory components	**Lab components:** Rubrics for each lab component are added, then taken average	**10**	**20**	**08**
	Lab CIE	**10**		
	TOTAL	**50**	**20**	

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	2	1	1	2	2	2	0	3
CO2	3	3	2	3	2	1	1	2	2	2	0	3
CO3	3	3	3	3	2	1	1	2	2	2	0	3
CO4	3	3	2	3	2	1	1	2	2	2	0	3
CO5	3	3	3	3	2	2	1	2	2	2	0	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)									
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2023-24
SEMESTER : FIFTH

Course Title	**COMPUTER AIDED DESIGN AND MANUFACTURING**	
Sub.Code:**21MET503**	No. of Credits:**3 = 3:0:0 (L-T-P)**	No. of Lecture Hours/Week:**03**
Exam Duration: **03** Hrs.	**Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100**	**Total No of Contact Hours: 40**
Category	**PCC**	
Pre-requisites	**Manufacturing process**	

COURSE OBJECTIVES:

1. Describe the importance of computers role of CAD/CAM in modern design and manufacturing
2. Comprehend and solve the basic mathematical elements of Computer Graphics.
3. Effective learning of NC & CNC technology and create simple CNC programs for machining operations.
4. To impart the use of CAD and CAM in the design and production preparation process.
5. Demonstrate the concept, configurations and features of Robotics along with its applications.

Sl. No.	**CONTENTS**	**Hrs**
UNIT-1	**INTRODUCTION**	**08**
	Role of computers in design and manufacturing influence of computers in manufacturing environment. Product cycle in convention to computerized manufacturing environment. Introduction to CAD. Introduction to CAM. Advantages and disadvantages of CAD and CAM, Types of surface generation and its applications. Automation, Types of Automation, Benefits of Automation, Levels of Automation, Design for manufacture	
UNIT-2	**GEOMETRIC TRANSFORMATIONS IN COMPUTER GRAPHICS**	**08**
	Software configuration of a graphic system. Function of graphics package, Elements of Solid Modeling, wire frame and solid modeling, CAD/CAM integration. Desirable modeling facilities and transformation.. **SOLID MODELLING** – Boundary Representation Cubic splines and Bezier curves and its characteristics	
UNIT-3	**NC, CNC, DNC TECHNOLOGIES**	**08**
	NC, CNC, DNC, modes. NC element, advantages and limitations of NC, CNC. Functions of computer in DNC. CNC tooling: Turning tool geometry, milling tooling system, tool presetting. ATC, work holding. Operational features of CNC machine; CNC Technology (Machine Spindle, Drives, Feedback devices etc.)	
UNIT-4	**CNC TURNING & MACHINING CENTERS**	**08**
	Introduction to CNC, elements of CNC, CNC turning & machining centers, part programming fundamental steps involved in development of part programming for milling and turning. Canned Cycles (Stock Removal, Threading, Grooving, Parting Off, Contour, Drilling, Face Milling, End Milling), Preparing the Process chart.	

UNIT-5	INTRODUCTION TO ROBOTICS	08
	Introduction, robot configuration, robot motion, programming of robots, end effectors work cell, control and interlock, sensor, robot applications. Kinematic Analysis – Direct and Inverse Kinematic analysis, numerical problems.	

REFERENCE BOOKS

1. Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) by Mikell Groover, Pearson Education INC, Fifth Impression, 2008.
2. CAD/CAM by P N Rao, Tata McGraw Hill, Sixth Reprint, 2006.
3. CAD/CAM by Ibrahim Zied, Tata McGraw Hill, Fourth Reprint, 2008.
4. Automation, Production Systems and Computer Integrated Manufacturing by Mikell P Groover, 4th Edition, 2015, Pearson Education INC.

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

CO1: Understand the possible applications of the CAD/CAM systems in structure analysis, optimize and virtual engineering.
CO2: Demonstrate the basic fundamentals that are used to create, manipulate and analyze Geometric models in a computer graphics.
CO3: Explain the basic concepts, features of NC, CNC, DNC machines.
CO4: Explain the features of machining centres and able to write part programmes for different operations and work parts.
CO5: Appraise the functions of robotic configurations, sensors, end effectors, Programming and able to analyze kinematic and dynamic motion of robot.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	1	1	1	1	1	1	2	1	1
CO3	3	3	3	1	2	1	1	1	1	2	1	1
CO4	3	3	2	1	2	1	1	1	1	2	1	1
CO5	3	2	3	2	3	1	1	1	1	2	2	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2023-24
SEMESTER : FIFTH

Course Title	**FLUID MECHANICS AND TURBOMACHINES**	
Sub.Code:**21MET504**	No. of Credits:**3 = 2:1:0 (L-T-P)**	No. of Lecture Hours/Week:**02** No. of Tutorial hours/week :**02**
Exam Duration: **03** Hrs.	**Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100**	**Total No of Contact Hours: 50**
Category	**PCC**	
Pre-requisites	**Elements of Mechanical Engineering**	

COURSE OBJECTIVES:

The objectives of this course are:

1. To understand the basic principles and equations of fluid mechanics.
2. To apply the knowledge of fluid mechanics to select appropriate measurement devices like pressure gauges, flow meters, pipes and other accessories for different field applications.
3. To develop skills to estimate the major and minor losses in pipes, efficiency of turbomachines like turbines, pumps and compressors, head on a pump and select a pump for a particular application.

#	CONTENTS	Hrs.
UNIT-1	**FLUID PROPERTIES, FLUID STATICS AND BUOYANCY**	**8L+2T**
	Introduction; Classification of fluids; Properties of fluid - viscosity, surface tension, capillarity, vapour pressure, cavitation phenomenon, compressibility; Fluid pressure at a point; Pascal's law; Hydrostatic law; Relation between absolute, gauge, atmospheric and vacuum pressures; Fluid pressure measurement - simple manometers and differential manometers; Hydrostatic forces on submerged plane surfaces - horizontal, vertical and inclined and curved surfaces; Buoyancy - center of buoyancy, metacentre and metacentric height; Stability conditions for floating and submerged bodies; Experimental and theoretical determination of metacentric height; Numerical problems.	
UNIT-2	**FLUID KINEMATICS, DYNAMICS, FLOW MEASUREMENT AND DIMENSIONAL ANALYSIS**	**8L+2T**
	Lagrangian and Eulerian descriptions; Types of fluid flow; Flow patterns and flow visualization; Flow velocity and acceleration; Velocity potential and stream function; Differential equations of continuity and momentum; Navier-Stokes equation; Bernoulli's equation and its application - venturimeter, orifice meter, pitot-tube; V-notch and rectangular notch; Dimensional analysis and modeling; Numerical problems;	
UNIT-3	**FLOW THROUGH PIPES, VISCOUS FLOW, FLOW PAST IMMERSED BODIES AND COMPRESSIBLE FLOW**	**8L+2T**

	Introduction; Major and minor losses through pipes; Darcy's and Chezy's equation for loss of head due to friction in pipes; Laminar flow and viscous effects - Reynold's number, critical Reynold's number; Laminar flow through circular pipe-Hagen Poiseille's equation; Laminar flow between parallel and stationary plates; Boundary layer concept, displacement, momentum and energy thickness; Flow past immersed bodies: Introduction, drag, lift, expression for lift and drag; Basics of compressible fluid flow - stagnation properties relationship, velocity of sound in a fluid, mach number, mach cone, propagation of pressure waves in a compressible fluid; Numerical problems.	
UNIT-4	**TURBOMACHINERY**	**8L+2T**
	Introduction; Parts of a turbomachine; Comparison with positive displacement machines; Classification of fluid machines; Euler's turbine equation; Alternate form; Degree of reaction and utilization factor; Steam and gas turbines – Impulse and reaction types; Compounding of impulse turbine; Effect of friction; Analysis of single and two stage impulse turbines; Reaction turbine – analysis, reheat factor, stage efficiency; Hydraulic turbines – Classification, Different efficiencies; Pelton, Francis, Kaplan and propeller turbines – Velocity triangles, Design parameters; Draft tube; Unit quantities and specific speed; Characteristic curves of hydraulic turbines; Numerical problems.	
UNIT-5	**CENTRIFUGAL PUMPS AND COMPRESSORS**	**8L+2T**
	Centrifugal pump – Introduction, main parts; Pump losses and efficiencies; Work done; Pre-rotation, Slip and slip coefficient; Minimum starting speed; Multistage centrifugal pumps; Cavitation; Priming; Maximum suction lift; Specific speed; Characteristic curves; Centrifugal compressors – Stage velocity triangles, slip factor, power input factor, Stage work Pressure developed, Stage efficiency, Compressibility and pre-whirl; Surging; Numerical problems. Computational Fluid Dynamics – Introduction, Solution procedure, Additional equations of motion, Grid generation and grid independence, Boundary conditions, Commercial CFD Packages.	

TEXT BOOKS:

1. A Textbook of Fluid Mechanics and Hydraulic Machines (SI Units), Dr. R.K. Bansal, Laxmi Publications (P) Limited, Revised 9th Edition, 2010.
2. A Textbook of Turbo Machines (S.I. Units), Dr. M.S. Govindegowda and Dr. A.M. Nagaraj, M.M. Publishers, 10th Edition, 2017.

REFERENCE BOOKS:

1. Fluid Mechanics: Fundamentals and Applications (SI Units), Yunus A. Cengel, John M. Cimbala. McGraw-Hill Publications (SIE), 3rd Edition, 2014.
2. Fluid Mechanics and Hydraulic Machines, R K Rajput, S Chand Publishers, Fully Revised Multicolour Edition, 2013.

MASSIVE OPEN ONLINE COURSES (MOOCs):

Students are encouraged to visit http:// www.nptel.ac.in (http:// www.swayam.gov.in) and register for the following MOOCs:

(i) Fluid Mechanics and its Applications (12 Weeks Course; July-Oct)

(ii) Computational Fluid Dynamics (12 Weeks Course; July-Oct)

(iii) Foundations of Computational Fluid Dynamics (08 Weeks Course; July-Sep)
(iv) Fluid Dynamics and Turbomachines (08 Weeks Course; July-Sep)

COURSE OUTCOMES (CO): On completion of the course, students will be able to:

CO1: Understand and apply the knowledge fluid properties used in the analysis of fluid behaviour, principles of pressure, fluid statics, buoyancy and floatation.
CO2: Apply the knowledge of fluid kinematics, dynamics, flow measurements, dimensional analysis while addressing problems of mechanical engineering.
CO3: Understand the minor and major losses during flow through pipes and concept of viscous flow, flow immersed bodies and compressible flow.
CO4: Understand different types of turbines & analyse their performance characteristics of various turbines.
CO5: Classify and analyse the various types of centrifugal pumps and compressors.

Course Out Comes	Level of CO	Program Outcomes												Programme specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		3	3	2	2	0	1	2	2	3	3	3	3	3	0	0
CO2		3	3	3	2	0	1	2	2	3	3	3	3	3	0	0
CO3		3	3	2	2	0	1	2	2	3	3	3	3	3	0	0
CO4		3	3	3	2	0	1	2	2	3	3	3	3	3	0	0
CO5		3	3	2	2	0	1	2	2	3	3	3	3	3	0	0

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										
3. Each full question shall have maximum of 3 sub-divisions										

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2023-24
SEMESTER : FIFTH

Course Title	**COMPUTER AIDED MANUFACTURING LABORATORY**	
Sub.Code:**21MEL505**	No. of Credits:**1 = 0:01:2 (L-T-P)**	No. of Practical Hours/Week**:02**
Exam Duration: **03** Hrs.	**CIE+SEE =50+50**	**Total No of Contact Hours: 26**
Category	**PCC Lab**	
Pre-requisites	**Manufacturing Processes**	

COURSE OBJECTIVES:

1. Computer based numerically controlled machine tools are increasingly finding place in industries.
2. Further integration of the computer Aided Design Drafting (CADD), which has been in use in the industry for some years now, with (CAM) Operations has led to efficient product design & prototyping and shorter production runs.
3. The need to absorb, CAD/ CAM technology for its effectives has, therefore, become imperative.
4. This course is being introduced as Practical course of BE programme in mechanical engineering.
5. The course aims at developing appreciation of the use of CAD/CAM environment, its Components, their functions, and methods of using the existing CAD/ CAM software, in general, with a view to improve efficiency in drafting and designing.

SL No.	CONTENTS	Hrs
PART A	➢ Three typical simulations to be carried out using simulation packages like Master- CAM, or any equivalent software. ➢ Simulation of Turning, Drilling, Milling operations.	**10**
PART B	➢ Executing NC part programming using software package like Spectra light or any equivalent software ➢ NC programming on milling operations, turning operations and drilling operations has to be written and executed.	**10**
PART C	**(ONLY FOR DEMO/VIVA VOCE)**	**06**
	➢ Pneumatics and Hydraulics, Electro-Pneumatics: Three typical experiments on Basics of these topics to be conducted. ➢ 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. ➢ Robot programming: Using Teach Pendent & Offline programming to perform pick and place, stacking of objects, 2 programs.	

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Gain the knowledge on CNC programming using CAM packages.

CO2: Learn and perform the programming and simulation robots.

CO3: Learn and understand the programming of automatic storage, retrieval system and linear shuttle conveyor system through demo.

CO4: Understand the function and handling of hydraulic, pneumatic and electro-pneumatic systems through demo.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	2	3	3	1	1	1	1	3	1
CO2	3	3	2	1	3	2	1	1	1	1	3	1
CO3	3	3	2	2	2	2	1	1	2	1	3	1
CO4	3	3	2	2	2	2	1	1	2	1	3	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

SCHEME OF EXAMINATION	
One questions from Part A	20 Marks (05 Write up +15)
One questions from Part B	20 Marks (05 Write up +15)
Viva Voce	10 Marks
TOTAL	**50 Marks**

ADMISSION YEAR: 2021-22 **ACADEMIC YEAR: 2023-24**
SEMESTER : FIFTH

Course Title	**RESEARCH METHODOLOGY & INTELLECTUAL PROPERTY RIGHTS**						
Course Code	**21RMT506**						
Category	Ability Enhancement Course(AEC)						
Scheme and Credits	No. of Hours/Week					Total teaching hours	Credits
	L	T	P	SS	Total		
	02	**00**	**00**	**00**	**02**	**25**	**02**
CIE Marks: 50 40+05(A)+05(GA)	**SEE Marks: 50**		**Total Max. marks=100**		**Duration of SEE: 02 Hours**		

COURSE OBJECTIVES:

1. Understand the knowledge on basics of research and its types.
2. Learn the concept of Literature Review and technical Reading.
3. Understanding the importance of giving credit to citations and attributions.
4. Learn ethics in Engineering Research.
5. Discuss the concepts of Intellectual Property Rights in engineering.

Sl. No.	CONTENTS	Hrs
UNIT-1	**INTRODUCTION**	**5**
	Introduction: Meaning of Research, Objectives of Engineering Research, and Motivation in Engineering Research, Research Process, 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. Copyright Infringements. Copyright Infringement is a Criminal Offence. Copyright Registration.	
UNIT-2	**LITERATURE REVIEW AND TECHNICAL READING**	**5**
	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.	
UNIT-3	**INTRODUCTION TO INTELLECTUAL PROPERTY**	**08**
	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. Commercialization of a Patent. Need fora Patent Attorney/Agent. Can a Worldwide Patent be Obtained, Do I Need First to File a Patent in India? Patent Related Forms. Fee Structure. Types of Patent Applications. Commonly Used Terms in Patenting. National Bodies Dealing with Patent Affairs. Utility Models.	
UNIT-4	**COPYRIGHTS AND RELATED RIGHTS**	**08**
	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.	
UNIT-5	**INDUSTRIAL DESIGNS & GEOGRAPHICAL INDICATIONS**	**08**
	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 theRegistration 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.	

TEACHING LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Understand the meaning of engineering research.

CO2: Recognize the procedure of literature review and technical reading.

CO3: Know the fundamentals of patent laws and drafting procedure.

CO4: Understand the subject matters of copyright laws and trademarks.

CO5: Realize the basic principles of design rights.

TEXT BOOKS:

1. Dipankar Deb, Rajeeb Dey, Valentina E. Balas "Engineering Research Methodology", ISSN 1868-4394 ISSN 1868-4408 (electronic), Intelligent Systems Reference Library, ISBN 978-981-13-2946-3 ISBN 978-981- 13-2947-0 (eBook), https://doi.org/10.1007/978-981-13-2947-0.
2. Intellectual Property A Primer for Academia by Prof. Rupinder Tewari Ms. Mamta Bhardwaj.

REFERENCE BOOKS:

1. David V. Thiel "Research Methods for Engineers" Cambridge University Press, 978-1-107-03488- 4.
2. Intellectual Property Rights by N.K.Acharya Asia Law House 6th Edition. ISBN: 978-93-81849-30-9.

ONLINE RESOURCES

1. https://www.slideshare.net/indravi/intellectual-property-rights-ipr-in-engineering
2. http://bspublications.net/downloads/050e6a699258c8_IPR_chapter1.pdf

SCHEME OF EXAMINATIONS

(i) The question paper will have ten full questions carrying equal marks.
(ii) Each full question will be for 10 marks.
(iii) There will be two full questions from each module.
(iv) Each full question will have sub-questions (subject to a maximum of four sub-questions)
(v) The students have to answer five full questions, selecting one full question from each module.

MAPPING OF COs WITH POs															
Course Out Comes	**Level of CO**	**Program Outcomes**												**Programme specific outcomes**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1			1				2		3		1				3	1
CO2			1				2		3		1				3	1
CO3			1				2		3		1				3	1
CO4			1				2		3		1				3	1
CO5			1				2		3		1				3	1
Strength of correlation: Low-1, Medium- 2, High-3															

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2024-25
SEMESTER : FIFTH

Course Title	**MODELLING AND SIMULATION LAB**	
Sub Code: **21MET5083**	No. of Credits: **1 = 0:0:2 (L-T-P)**	No. of Practical Hours/Week**:01**
Exam Duration:02 Hrs.	**CIE+SEE =50+50**	Total No of Contact Hrs. 13
Category	**AEC Lab**	
Pre-requisites	**Mechanics of Materials, Manufacturing Processes**	

Course Learning Objectives:	
1	To Create drawings and models using software
2	To Create solid models using sketching, extruding
3	Gaining a working knowledge of CAD solid modeling
4	Theoretical concepts of engineering graphics, including orthographic projection, auxiliary views and sectioning,
5	General dimensioning and tolerance, and geometric dimensioning and tolerance.

UNIT No.	**Syllabus**	**No. of hours**	**BTLs**
1	**SURFACE MODELING**	**04**	**L4**
	(i) Create semi-finished bottom casing of a smart Phone using surface tools. (ii) Create semi-finished top casing of a mouse using surface tools. A mouse is a pointing device that functions by detecting two dimensional motion relative to its supporting surface.		
2	**SIMULATION**	**04**	**L4**
	Static analysis of L shaped Cantilever Beam- (i) Determine displacement due to elongation (ii) Determine displacement and elongation due to bending (iii) Modal analysis of L shaped cantilever Beam		
3	**SHEET METAL DESIGN**	**04**	**L4**
	(i) Create a sheet metal body required for a SMPS (Switch Mode Power Supply) in a computer (ii) Create a Sheet Metal Hopper Design		
4	**WELDMENT**	**02**	**L4**
	(i) Create industrial steel frame using weldment (ii) Create a piping structure using weldment		

Course Outcomes: On completion of the course, student should be able to:	
1	Ability to create features complex faces and edges
2	Use Base Flange, Extruded Cut, Sketched Bend and Edit Material commands
3	Create weldment using software for industrial frames
4	Able to conduct static and dynamic analyses for mechanical components

Course Out Comes	**Level of CO**	**Program Outcomes**												**Programme specific outcomes**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1		3	3	3	3	2	0	0	0	0	0	2	0	3	0	0
CO2		3	3	3	3	2	0	0	0	0	0	2	0	3	0	0
CO3		3	3	3	3	2	0	0	0	0	0	2	0	3	0	0
CO4		3	3	3	3	2	0	0	0	0	0	2	0	3	0	0
CO5		3	3	3	3	2	0	0	0	0	0	2	0	3	0	0

Text Books and Learning Sources	
1	https://www.sdcpublications.com/Textbooks/Machining-Simulation-Using-SOLIDWORKS-CAM/ISBN/978-1-63057-570-0/
2	https://www.sdcpublications.com/Textbooks/Hands-On-Introduction-SOLIDWORKS-2023/ISBN/978-1-63057-555-7/
3	https://www.youtube.com/watch?v=lnJTfrqYfMU

Sl. No.	**Particulars**	**Max Marks**	**Break up Max. Marks**	
			Write up	**Modelling**
Q 1	Any one from either from Unit 1 or Unit 2	25	5	20
Q 2	Any one from either from Unit 3 or Unit 4	15	5	10
Q 3	**Viva Voice**	10	-	-
Total		**50**		

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2023-24
SEMESTER : FIFTH

Course Title	**MANAGEMENT AND ENTREPRENEURSHIP**	
Sub.Code:**21MET601**	No. of Credits:**03 = 3:0:0 (L-T-P)**	No. of Lecture Hours/Week:**03**
Exam Duration: **03** Hrs.	**Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100**	Total No. of Contact Hours**: 40 Hrs.**
Category	**HSSC**	
Pre-requisites	**Elements of Mechanical Engineering**	

COURSE OBJECTIVES:

1. To impart the knowledge about the Management concepts, evolution and Management functions.
2. To familiarize the student on Entrepreneurship and Entrepreneurial process.
3. To understand the role of SSI in economic development and gain an insight of funding agencies.
4. To have a clear understanding of concept of project, preparation of project & its screening.

#	CONTENTS	Hrs
UNIT-1	**MANAGEMENT**	**08**
	Introduction- Meaning, characteristics of management, functions of Management- POSDCORB, Levels and Skills of Management, Roles of Managers Management as science or an art or profession, Development of management thought -**Early management approaches (in brief)**- Psychological, Bureaucratic, Scientific theory and Administrative theory and Human Relations Movement, **Modern management approaches (in brief)**- Behavioral, Systems, Quantitative, and Contingency approach. **FUNCTIONS OF MANAGEMENT- PART I:** **PLANNING:** Types of Plans: Single use & Standing plans, Steps in Planning process. **ORGANIZING:** Types of organization (Line, Staff, Line & Staff, Matrix and Committee form) Departmentation (Functional, Product, Process, Territorial and Customer), MBO and MBE.	
UNIT-2	**FUNCTIONS OF MANAGEMENT – PART II**	**08**
	STAFFING: Sources of recruitment, Process of selection, **DIRECTING:** ***Leadership*****:** Definition, Leadership styles - Autocratic, Democratic, Charismatic, Laissez faire and Participative, ***Motivation:***– Definition, Maslow, Herzberg & McGregor's Theory X & Y. ***Communication***– Definition, types, communication process and barriers of communication, ***CO-ORDINATION*****:** importance, **CONTROLLING:** steps in controlling, **REPORTING**: importance, **BUDGETTING**: importance ***Case study discussion with respect to Indian context.***	
UNIT-3	**ENTREPRENEUR**	**08**

	Definition & Meaning, Characteristics, types of entrepreneurs- Imitative, Innovative, Fabian and drone and Others, Intrapreneur- meaning, Difference between Entrepreneurs, Intrapreneur & Manager, Stages in Entrepreneurial process, barriers to entrepreneurs, Role of Entrepreneurs in economic development and Business Plan. **Rural entrepreneurship**– Definition, challenges & opportunities. **Women Entrepreneurs** – Definition, challenges, and Institutional support to Women Entrepreneurs in India. **Family Business:** Meaning and Definition, types of family business and reasons for failure of family business. **Corporate Social Responsibility**- Meaning, definition and benefits. ***Case study discussion with respect to Indian context.*** ***Activity: Profile of successful entrepreneur and Writing Business plan***	
UNIT-4	**MSME**	**08**
	Definition of MSME (latest). **SMALL SCALE INDUSTRY**: Meaning, and definition, Characteristics, steps to start SSI, role of SSI in economic development, problems faced by SSI. Introduction to GATT, WTO &LPG, Sources of financing (brief), Forms of ownership - Sole proprietorship, Hindu Undivided Family, Partnership, and Cooperative. **Institutional Support**: ***Central level Institutions*** – NBMSME, KVIC, NSIC, SIDBI, Indian Institute of Entrepreneurship (IIE), EDI and NABARD. S***tate level Institutions***- DIC, KSFC, KIADB, TECSOK. **STARTUP COMPANIES**-Meaning and Challenges. Make in India concept and MUDRA Bank Initiative. ***Activity for students: Schemes for startup companies.***	
UNIT-5	**PREPARATION OF PROJECT**	08
	Project- Meaning, Classification of project, Project identification, Project selection, Project Appraisal, Project implementation. Project Report –Outline, Feasibility Study-Financial, Technical, Marketing, and Social Feasibility Study, PESTLE Analysis for Project and errors in preparation of project report. ***Activity for students*: *Preparation of project report***	

TEXT BOOKS:

1. Entrepreneurship and Management- S Nagendra and V S Manjunath- Pearson Publication 4 /e,2009.
2. Principles of Management – PC Tripathi, and P N Reddy – Tata MacGrawHill.
3. Entrepreneurship Development – Poornima M Charanthimath Pearson Education 2nd Edition.

REFERENCE BOOKS:

1.Dynamics of Entrepreneurial Development and Management-Vasant Desai-Himalaya Publishing House. Latest edition.

2. Entrepreneurship and management - Shashi k Gupta- Kalyani publishers, Latestedition.
3.Financial Management- Shashi k Gupta- Kalyani publishers, Latestedition.

COURSE OUTCOMES: After completion of the course, students will be able to:

CO1: The students will gain domain knowledge on management concepts, evolution, management functions.

CO2: The students will be able to gain domain knowledge on Entrepreneurship, entrepreneurial process

CO3: The students will get an in depth knowledge of entrepreneurial process & contribute to the betterment of the society.

CO4: Students will be able to identify business opportunities & design a project report.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	2	2	1	1	0	0	0	0	2
CO2	3	3	3	2	2	1	2	0	0	0	1	2
CO3	3	3	3	2	2	2	2	0	1	0	1	3
CO4	3	3	3	2	2	2	2	0	1	0	2	3
CO5	3	3	3	3	3	2	2	0	1	0	2	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2022-23 ACADEMIC YEAR: 2023-24
SEMESTER : SIXTH

Course Title	**HEAT TRANSFER**	
Sub Code: **21MET602**	**No of Credits: 04** **L-T-P 2:1:1:0 =04**	**No. of Lecture Hours/Week:02** **No. of Tutorial Hours/Week:02** **No. of Practical hours/week :02**
Exam Duration: 3 hrs.	**CIE+SEE=50+50=100**	**Total No of Contact Hours: 52 + 13 lab Slots**
Category	**IPCC**	
Pre-requisites	**Engineering Mathematics, Engineering Thermodynamics and Fluid Mechanics**	

Course Learning Objectives:	
1	To outline the basic concepts of conduction, convection and radiation heat transfer and illustrate the application of various boundary conditions giving heat transfer examples.
2	To understand the unsteady heat conduction and convection heat transfer and apply the knowledge to solve real time problems.
3	To demonstrate the use of graphical charts for solving analytical problems.
4	To design heat exchangers based on the input variables such as inlet temperature of hot and cold fluids.
5	To calculate various heat transfer parameters and predict the rate of heat transfer and heat transfer coefficients.
6	To evaluate the conductivity, heat transfer coefficients, emissivity and other performance parameters of equipment like heat exchangers and refrigerators through laboratory experiments.

UNIT No.	**Syllabus**	**No. of hours**	**RBTLs**
1	**BASIC CONCEPTS AND CONDUCTION HEAT TRANSFER**	**9L+4P**	**L1, L2, L3**
	Introduction - Modes of heat transfer, Basic laws, Combined heat transfer mechanism, Resistance concept, Boundary conditions of 1st, 2nd and 3rd kind; Thermal contact resistance; Overall heat transfer coefficient; Illustrations of applying the boundary conditions to heat transfer problems; Derivation of general equation of heat conduction in Cartesian coordinates; Special cases; Discussion on 3-D conduction in cylindrical and spherical coordinate systems (No derivation);Steady state heat conduction in simple and composite slabs, cylinders and spheres (uniform thermal conductivity and without heat generation); Related numerical problems; Introduction to variable thermal conductivity and heat generation; Concept and derivation of critical thickness of insulation in cylinders and spheres; Related numerical problems		
2	**EXTENDED SURFACES AND UNSTEADY STATE HEAT CONDUCTION TRANSFER**	**9L+4P**	**L1, L2, L3**
	Introduction to extended surfaces; Derivation of heat transfer and temperature distribution in fins (uniform cross-section without heat generation); Long fin, short fin with insulated tip and without insulated tip and fin connected between two heat sources; Fin efficiency and effectiveness; Related numerical problems.		

	Unsteady state heat conduction - Introduction; Conduction in solids with negligible internal temperature gradient (Lumped system analysis), Use of Transient temperature charts (Heisler's charts) for transient conduction in slab, long cylinder and sphere; Use of transient temperature charts for transient conduction in semi-infinite solids; Related numerical problems.		
3	**CONVECTION HEAT TRANSFER**	**9L+4P**	**L1, L2, L3**
	Introduction – Boundary layer concept in external and internal flow; Forced Convection - Dimensional analysis for forced convection; Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers; Use of correlations for flow over simple geometries (flat plate, cylinder and sphere); Use of correlations for flow inside a duct; Numerical problems; Free or natural convection - Dimensional analysis for free convection; Physical significance of Grashof number; Use of correlations of free convection over flat plates (vertical, horizontal and inclined), cylinders (vertical and horizontal) and spheres; Related numerical problems; Introduction to boiling: pool boiling, Bubble Growth Mechanisms, Nucleate Pool Boiling, Critical Heat Flux in Nucleate Pool Boiling, Pool Film Boiling, Critical Heat Flux, Heat Transfer beyond the Critical Point, filmwise and dropwise Condensation Related numerical problems		
4	**HEAT EXCHANGERS**	**9L+4P**	**L1, L2, L3**
	Introduction; Classification of heat exchangers; Compact, Shell-and-tube and Plate heat exchangers; Overall heat transfer coefficient and fouling factor; Parallel and counter flow heat exchangers; Use of LMTD; Heat transfer with phase change; Multi pass and cross-flow heat exchangers; Effectiveness-NTU method; Limiting cases; Related numerical problems; Compact heat exchangers – Introduction, types, advantages.		
5	**RADIATION HEAT TRANSFER**	**9L+4P**	**L1, L2, L3**
	Introduction; Fundamental principles - Gray, White, Opaque, Transparent and Black bodies, Spectral emissive power, Wien's displacement law, Planck's laws, Hemispherical Emissive Power, Stefan-Boltzmann law for the total emissive power of a black body, Emissivity and Kirchhoff's Laws; Black bodies separated by a non-absorbing medium; Shape factor; Electrical analogy; Two black surfaces connected by non-conducting and re-radiating walls; Evaluation of shape factor; Radiation heat transfer between gray bodies; Radiosity and Irradiation; Radiation network for gray surfaces exchanging energy; Radiation shields; Related numerical problems		

LABORATORY WORK:

Exp No.	LIST OF EXPRIMENTS	No. of hours	RBTLs
	PART - A		
1	**MINOR EXPERIMENTS** 1. Composite wall - Determination of overall heat transfer coefficient of a composite wall. 2. Metal rod - Determination of thermal conductivity of a metal rod. 3. Fin – Determination of efficiency and effectiveness of a fin free convection mode. 4. Emissivity - Determination of emissivity of a given grey surface.	**10**	**L4**
	PART - B		
2	**MAJOR EXPERIMENTS** 1. Vertical pipe - Determination of heat transfer coefficient in free convection mode. 2. Pipe flow - Determination of heat transfer coefficient in forced convection mode for hot air flowing through a circular pipe. 3. Stefan Boltzmann constant - Verification of Stefan Boltzmann Constant. 4. Fin - Determination of efficiency and effectiveness of a fin in forced convection mode. 5. Shell and Tube heat exchanger - Determination of Log Mean Temperature Difference (LMTD) and Effectiveness in (i) Parallel Flow mode and (ii) Counter Flow mode 6. Vapour Compression Refrigerator (VCR) – Determination of COP.	**16**	**L4**

Course Outcomes:	
1	*Understand* the basic modes of heat transfer and critical thickness of insulation. (RBTL: 1, 2, 3)
2	*Understand* the application of extended surfaces in heat conduction and unsteady conduction heat transfer through solids. (RBTL: 1, 2, 3)
3	*Interpret* and *analyse* the convection heat transfer and phenomenon of boiling and condensation (RBTL: 1, 2, 3)
4	*Analyse* and *design* the heat exchanger for the maximum effectiveness and efficiency. (RBTL: 1, 2, 3)
5	*Understand* the principles thermal radiation heat transfer and *develop* expressions for net radiation between various types of bodies. (RBTL: 1, 2, 3)
6	*Conduct* experiments on basic modes of heat transfer and performance tests on heat exchanger and vapour compression refrigerator.

Course Outcomes Mapping with Programme Outcomes & Programme Specific Outcomes.

Course Out Comes (CO)	Level of CO	Program Outcomes (PO)												Programme Specific Outcomes (PSO)		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	L1, 2, 3	3	3	2	2	0	0	0	0	0	0	0	0	3	0	0
CO2	L1, 2, 3	3	3	3	2	0	0	0	0	0	0	0	0	3	0	0
CO3	L1, 2, 3	3	3	2	2	0	0	0	0	0	0	0	0	3	0	0
CO4	L1, 2, 3	3	3	3	2	0	0	0	0	0	0	0	0	3	0	0
CO5	L1, 2, 3	3	3	2	2	0	0	0	0	0	0	0	0	3	0	0
CO6	L4	0	0	2	2	0	0	0	0	2	0	0	0	0	0	0

Text Books.	
1	**Heat and Mass Transfer,** P.K. Nag, 3rd Edition, Tata McGraw-Hill Publications, 2011.
2	A Text Book of Heat and Mass Transfer (SI Units) – R. K. Rajput, S. Chand & Company Limited, Revised Edition 2018.

Data Hand Books and Charts	
1	**Heat and Mass Transfer Data Hand Book,** C.P. Kothandaraman, S. Subramanyan, New Age International Publishers, 8th Edition, 2014.
2	Thermodynamics Data Handbook – B.T. Nijaguna and B.S. Samaga, Sudha Publications, 2016.

Reference Text Books.	
1	**Heat and Mass Transfer: Fundamentals and Applications**, Cengel,Y.A., and Ghajar, A.J., 5th Edition, McGraw-Hill Publications (SIE), 2015.
2	**Principles of Heat and Mass Transfer**, Frank P. Incropera, David P. Dewitt, Theodore L. Bergman, and Adrienne S. Lavine, 7th Edition, Wiley Student Edition, 2013.

Web Links.	
1	Students are encouraged to visit http:// www.nptel.ac.in (http:// www.swayam.gov.in) and register for the following MOOCs: (i) Fundamentals of Convective Heat Transfer (12 Week Course; July-Oct) (ii) Heat Exchangers: Fundamentals and Design Analysis (12 Week Course; July-Oct) (iii) Conduction and Convection: Fundamentals and Applications (12 Week Course; July-Oct) (iv) Fundamentals of Conduction and Radiation (12 Week Course; July-Oct)

Assessment Details both (CIE and SEE)
The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass. **CIE:** The CIE has two components – CIE - theory component and CIE – laboratory component. Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE. Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.

CONTINUOUS INTERNAL EVALUATION (CIE)		**Max Marks**		**Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually)**
Theory	**Weightage of CIE1 and CIE2 Tests or CIE3**	**30**		**12**
Laboratory components	**Lab components:** Rubrics for each lab component are added, then taken average	**10**	**20**	**08**
	Lab CIE	**10**		
TOTAL		**50**		**20**

CIE PATTERN		
Sl. No.	**Particulars**	**Max Marks**
Q 1	Any one question from Part -A	15
Q 2	Any one question from Part -B	25
Q 3	Viva Voice	10
		50 (Scale down to 10)

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	2	1	1	2	2	2	0	3
CO2	3	3	2	3	2	1	1	2	2	2	0	3
CO3	3	3	3	3	2	1	1	2	2	2	0	3
CO4	3	3	2	3	2	1	1	2	2	2	0	3
CO5	3	3	3	3	2	2	1	2	2	2	0	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2023-24**
SEMESTER : SIXTH

Course Title	**MECHANICAL VIBRATIONS**	
Sub.Code:**21MET603**	No. of Credits:**03 = 3:0:0 (L-T-P)**	No. of Lecture Hours/Week**:03**
Exam Duration: **03** Hrs.	**Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100**	Total No.of Contact Hours:**40**
Category	**PCC**	
Pre-requisites	**Engineering Physics, DOM**	

COURSE OBJECTIVES:

1. To study basic concepts of vibration analysis in mechanical systems, various technique to solve single degree freedom with and without damping. Estimate natural frequency of simple mechanical system using various numerical techniques.
2. To study the vibration parameters numerically for forced vibration and also acquaint with the principles of vibration measuring instruments.
3. To determine fundamental natural frequencies of two degree freedom systems without damping and semi definite systems
4. To estimate the natural frequency of multi DOF system using various numerical methods.
5. To study balancing of mechanical systems, and able to mathematically formulate real-world vibration problems in engineering.

#	CONTENTS	Hrs
UNIT-1	**BASIC CONCEPTS OF VIBRATION:** Vibration and oscillation, causes and effects of vibrations, Vibration parameters – spring, mass, damper, Damper models, Motion – periodic, non-periodic, harmonic, non- harmonic, Degree of freedom, static equilibrium position, Vibration classification, Steps involved in vibration analysis. Definitions, Simple Harmonic Motion (S.H.M.), Work done by harmonic force, Beats and Numerical. **FREE UNDAMPED SINGLE DEGREE OF FREEDOM VIBRATION SYSTEMS:** Longitudinal, transverse, torsional vibration system, Methods for formulation of differential equations by Newton, Energy and Rayleigh's Method, Different methods of determination of natural frequencies of simple systems, Springs in series and parallel, Torsional and transverse vibrations, Effect of mass of spring and problems.	**08**
UNIT-2	**FREE DAMPED SINGLE DEGREE OF FREEDOM VIBRATION SYSTEMS:** Types of damping**,** Analysis with viscous damping - Derivations for over damped, critically damped and under damped systems, Logarithmic decrement and numerical.	**08**
UNIT-3	**FORCED VIBRATIONS:** Introduction**,** Analysis of forced vibration with constant harmonic excitation - magnification factor, rotating and reciprocating unbalances, support excitation for relative and absolute amplitudes, force and motion transmissibility and numerical. **Rotor Dynamics:** Critical speed of single rotor, undamped and damped vibrations and numerical. **Vibration Measurement**: Principle of seismic instruments, vibrometer, and accelerometer - undamped, damped, Frequency measuring instruments.	**08**

UNIT-4	**SYSTEMS WITH TWO DEGREES OF FREEDOM:** Principle modes and normal modes of vibrations, natural frequencies of systems (without damping) – Simple spring mass systems, torsional systems, combined rectilinear and angular systems, geared semi-defined systems, semi-definite systems, Dynamic vibration absorber and numerical.	**08**
UNIT-5	**NUMERICAL METHODS FOR MULTI DEGREE FREEDOM OF SYSTEMS**: **(A) Free Undamped Multi Degree Freedom System:** Introduction, Maxwell's reciprocal theorem, Influence coefficients, and numerical. **(B) Multi Degree System Numerical Methods:-** (i) Rayleigh`s, (ii) Dunkerley's (iii) Holzer`s Numerical	**08**

TEXT BOOKS:

1. **Mechanical Vibrations,** G. K.Grover, Nem Chand and Bros, 7th edition, 2003.
2. **Mechanical Vibrations,** S. S. Rao, Pearson Education Inc, 4th edition, 2003.
3. **Mechanical Vibrations,** V. P. Singh, Dhanpat Rai& Company, 3rd edition, 2006.

REFERENCE BOOKS:

1. **Theory of Vibration with Applications,** W. T. Thomson, M. D. Dahleh and C. Padmanabhan, Pearson Education Inc, 5th edition, 2008.
2. **Mechanical Vibrations:** S. Graham Kelly, Schaum's outline Series, Tata McGraw Hill, Special Indian Edition, 2007.
3. **Theory and Practice of Mechanical Vibrations:** J. S. Rao& K. Gupta, New Age International Publications, New Delhi, 2001.
4. **Vibration Fundamentals**, R. Keith Mobley, Newness, 1999.

COURSE OUTCOMES: After completion of the course, students will be able to:

CO1: Understand the different methods to determine the fundamental natural frequencies of SDOF without damping.
CO2: Solve the different parameters of single degree damped vibrations by the basic knowledge of damped vibration.
CO3: Able to find vibration parameters numerically for forced vibration and also explore modern vibration measuring instruments and rotor dynamics.
CO4: Determine fundamental natural frequencies of two degree freedom systems without damping and semi definite systems.
CO5: Find the influence of coefficient of spring mass system and apply the numerical methods to find the frequency of multi degree freedom system.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	2	2	1	1	0	0	0	0	2
CO2	3	3	3	2	2	1	2	0	0	0	1	2
CO3	3	3	3	2	2	2	2	0	1	0	1	3
CO4	3	3	3	2	2	2	2	0	1	0	2	3
CO5	3	3	3	3	3	2	2	0	1	0	2	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2023-24
SEMESTER : SIXTH

Course Title	**INSPECTION AND QUALITY CONTROL (PROFESSIONAL ELECTIVE COURSE– 1)**	
Sub.Code:**21MET6041**	No. of Credits:**03 = 3:0:0 (L-T-P)**	No. of Lecture Hours/Week**:03**
Exam Duration: **03** Hrs.	**Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100**	Total No.of Contact Hours:**40**
Category	**PEC**	
Pre-requisites	**Engineering Mathematics**	

COURSE OBJECTIVES:

1. The student should learn different inspection procedures, objectives in industry and economic aspects.
2. To impart definition of quality, components, concepts and different approaches followed like quality circles, cost of quality and economic considerations in quality.
3. To impart knowledge on various quality standards followed.
4. To impart fundamentals of statistical quality control charts, and process capability.
5. To impart different sampling techniques and reliability.

#	CONTENTS	Hrs.
UNIT-1	**INDUSTRIAL INSPECTION and CONCEPT OF QUALITY IN ENGINEERING**	**08**
	Industrial inspection: Objectives and functions of inspection in industry, types of inspection, production / inspection interaction, organization for industrial inspection, inspection procedures, economic aspect of inspection. **Concept of Quality in Engineering:** Meaning and significance of quality; essential components of quality; phases or elements for building quality; evolution of the concepts of quality; spiral of progress of quality; quality cost, hidden quality costs; economic models of quality costs, changing scope of quality activities.	
UNIT-2	**QUALITY MANAGEMENT SYSTEMS , QUALITY CONTROL FUNCTION and ASPECTS OF SPECIFICATION AND TOLERANCES**	**08**
	Quality Control Function: Inspection versus quality control techniques, quality planning activities, organization for quality control. Fundamentals of statistical quality control, Juran's quality trilogy. **Aspects Of Specification And Tolerances:** Aspects of Specification and Tolerances: purpose of specification and tolerances, effect of careless setting of specification limits, setting realistic tolerances, statistical tolerancing, statistical theorem, Precision. Reproducibility and Accuracy, Simple numerical problems.	
UNIT-3	**CONTROL CHARTS**	**07**
	Control Charts: Basics of Control Chart: Variability, Kinds of variations, Types of errors, Control limits specification limits and Natural Tolerance limits, Charts for variables and attributes, application of control charts for averages, range, standard deviation, Interpretation of X-bar and R Charts- cyclic patterns, mixture, shift, trend and stratification, fraction defectives (p Chart) and number of non-conformities per unit (c Chart), process capability analysis and simple numerical problems.	
UNIT-4	**ACCEPTANCE SAMPLING & RELIABILITY**	**08**

	Acceptance Sampling: Elementary concepts, sampling by attributes, single, double and multiple sampling plans, construction and use of operating characteristic curves and problems on single sampling plan. **Reliability:** Reliability engineering, rectification processes in industries, practical activity – quality report building, reliability function, failure rate, mean time between failures (MTBF), mean time to failure (MTTF), mortality curve, useful life availability, maintainability, system effectiveness and simple numerical problems on reliability, MTBF and MTTF.	
UNIT-5	**QUALITY TOOLS AND SYSTEMS & TOTAL QUALITY MANAGEMENT**	**08**
	Quality Management Systems: Introduction to various quality standards - ISO 9000, BIS. **Quality Tools:** Ishikawa's seven quality tools; Quality Circles; Quality system economics. **Total Quality Management (TQM)** – definition, objectives, philosophy, and total productive maintenance (TPM) – definition, objectives, principles, implementation of TPM. Difference between TQM and TPM.	

TEXT BOOKS

1. Juran, J. M. and Gryna, F. M., Quality Planning & Analysis, Tata McGraw Hill, New Delhi (1995).
2. Grant, E. L., Statistical Quality Control, McGraw Hill International, New York (2005).
3. Charles E Ebling, An introduction to reliability and maintainability engineering, Tata McGraw-Hill Education, 2004 – Maintainability (Engineering).

REFERENCE BOOKS

1. Feignbaum, A. V., Total Quality Control, McGraw Hill International, New York (1991).
2. Besterfield, D.H., Total Quality Management, Pearson Education Asia, New Delhi (2003)

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Gain a knowledge on industrial inspection activity and concept of quality in engineering.

CO2: Understand various quality systems, quality control function, specification and tolerances prevalent in industry.

CO3: Construct various control charts based on data available in an industrial production, can also dwell upon the status of a process whether in control or out of control and find number of defectives.

CO4: Carry out sampling, reliability techniques with an industrial application.

CO5: Learn about applying different quality tools and total quality management.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	3	1	0	0	2	1	2	2
CO2	3	3	2	1	3	1	0	0	1	1	2	1
CO3	3	3	2	1	3	1	0	0	2	1	2	2
CO4	3	2	3	1	3	1	0	0	2	1	2	2
CO5	3	3	2	1	3	1	0	0	2	1	2	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2023-24
SEMESTER : FIFTH

Course Title	**ADVANCED WELDING TECHNOLOGY (PROFESSIONAL ELECTIVE COURSE– 1)**	
Sub.Code:**21MET6042**	No. of Credits:**03 = 3:0:0 (L-T-P)**	No. of Lecture Hours/Week**:03**
Exam Duration: **03** Hrs.	**Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100**	Total No.of Contact Hours:**40**
Category	**PCC**	
Pre-requisites	**Manufacturing Processes**	

COURSE OBJECTIVES

1. To understand the working principle, advantages, disadvantages of arc, gas and thermit welding, types of weld joints, heat effects weld ability, preheating and post heating.
2. The student gains information on different solid-state and underwater welding processes.
3. To understand the power beam welding, brazing, soldering and thermal cutting processes.
4. To understand the welding metallurgy and weld ability.
5. To understand the Weldment inspection and testing codes governing welding inspection.

#	CONTENTS	Hrs.
UNIT 1	**INTRODUCTION OF WELDING:**	**08**
	Classification of welding processes, energy sources used in welding, types of fusion welds: working principle, process variables, advantages, limitations and applications of electro slag and electro gas welding, resistance spot welding, gas welding, plasma arc welding and thermit welding. And types of joints, Design considerations, Heat effects, and Weld ability and join ability. Elements and construction of welding symbols. Preheating and interpass heating, post weld heating, heating processes, post heat treatments, insulation of heated joints. Simple Problems.	
UNIT 2	**ADVANCED WELDING PROCESSES:**	**08**
	Working principle, process variables, advantages, limitations and applications of Forge welding, Forge-seam welding, cold welding, roll welding, friction welding and Inertia welding, friction stir welding, ultrasonic welding, diffusion welding and explosion welding. Introduction to wet and dry under water welding & cutting Introduction, welding techniques, difficulties and advantages of welding in space.	
UNIT 3	**HIGH ENERGY BEAM WELDING PROCESSES, BRAZING, SOLDERING AND THERMAL CUTTING:**	
	Working principle, process variables, advantages, limitations and applications of Electron beam and Laser beam welding Weld joint preparation and temperature control, checks prior to weld joint preparation, joint preparation checks, preheating and inter pass heating, post weld heating, heating processes, post heat treatments, insulation of heated joints. Introduction, brazing, soldering, various techniques, their advantages, limitations and applications; brazing & soldering consumables. Oxy Acetylene cutting-	

	working principle, metal powder cutting, introduction to oxygen/air / plasma / metal arc cutting arc cutting and gouging; advantages, limitations and applications of various techniques.	
UNIT 4	**WELDING METALLURGY AND WELDABILITY:**	**08**
	Principle of solidification of weld metal, modes of solidification, effect of welding parameters on weld structure, grain refinement principle of weld metal, method of weld metal refinement, inoculation, arc pulsation, external excitation. Thermal cycles, prediction of peak temperature, pre heat and cooling rate, Heat affected zone and weld metal: Transformations in HAZ of steel, factors affecting changes in microstructure and mechanical properties of HAZ, reactions in weld pool- gas metal reaction, slag metal reaction. Weld ability of carbon steel, stainless steel & aluminum. Hot & cold cracking phenomenon, weld defects, causes and their remedies. Welding of Cu, Al, Ti and Ni alloys – processes, difficulties, microstructures, defects and remedial measures.	
UNIT 5	**WELDMENT INSPECTION AND TESTING CODES GOVERNING WELDING INSPECTION:**	
	Structural welding code; ASME boiler and pressure vessel code, spot examination of welded joints, duties of the inspector, ASTM standards, API standards. Magnetic particle and Radiographic inspection. Magnetic particle inspection, types of magnetizing currents, demagnetization, interpretation of patterns, on-relevant indications, radiographic sources, detectable discontinuities. Chemical, Metallurgical, and Mechanical testing of weldments. Comparison of destructive and non-destructive tests, chemical tests, forms of corrosion, testing for corrosion resistance, metallographic tests. Visual and liquid penetrate inspection. Selection of NDT method, relationship of welding processes, discontinuities and inspection methods, visual inspection prior to, during and after welding, liquid penetrate test.	**08**

TEXT BOOKS:

1. S.V.Nadkarni, "Modern Arc Welding Technology", Oxford & IBH.
2. R.Little, "Welding Technology, TMH. WELDING CODES AND STANDARDS ME-9111 L T P.
3. Welding metallurgy by Sindo Kou, Welding metallurgy, 2nd Edition Nov. 2002, Wiley

REFERENCE BOOKS:

1. H.B.Cary, "Modern Arc Welding Technology", Englewood Cliffs, Prentice Hall.
2. Leonard P Connor, Welding Hand book, Volume I-III, AWS.
3. Metals Hand book, Volume 6, American Society of Metals.
4. Dave Smith, "Welding skills and technology", McGraw Hill.
5. Parmer R. S., 'Welding processes and Technology", Khanna Publishers, 1997
6. Robert W Messler, Jr. "Principles of welding, Processes, physics, chemistry and metallurgy", Wiley,2004.
7. Larry Jeffus, " Welding Principles and Applications" Fifth edition, Thomson,2002
8. Christopher Davis, 'Laser Welding - A Practical Guide', Jaico Publishing House, 1994.
9. Mishra. R.S and Mahoney. M.W, Friction Stir Welding and Processing, ASM,2007
10. Lancaster J F, "Metallurgy of welding", Allen and Unwin Co.

11. Larry J and Jeffus L, "Welding Principles and Applications", 5th edition, Delmer Publications.

COURSE OUTCOMES: On completion of the course, student should be able to;

CO1: Understand the mechanism, working principle and process characteristics of different 1.arc, gas and thermit welding, types of weld joints, heat effects weld ability, preheating and post heating.

CO2: Have in depth knowledge on working principle, process characteristics of friction, friction stir, ultrasonic, explosion welding and diffusion bonding and under water welding technique.

CO3: Describe the mechanism, working principle and process characteristics of high energy beam welding, **s**oldering and brazing and thermal cutting.

CO4: Understand welding metallurgy, weld ability of different metals, hot& cold cracking phenomenon, weld defects and their causes and remedies.

CO5: Understand the weldment inspection and testing codes governing welding inspection

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	3	1	2	0	1	1	1	1	1	0
CO2	2	3	2	1	2	0	0	1	1	2	1	1
CO3	3	3	2	1	2	0	1	1	1	2	1	1
CO4	2	3	3	1	2	0	0	1	1	2	0	1
CO5	3	2	3	1	2	0	1	1	0	1	1	0
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)									
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2023-24
SEMESTER : SIXTH

Course Title	**MODERN MOBILITY & AUTOMOTIVE MECHANICS (PROFESSIONAL ELECTIVE COURSE– 1)**	
Sub.Code:**21MET6043**	No. of Credits:**03 = 3:0:0 (L-T-P)**	No. of Lecture Hours/Week**:03**
Exam Duration: **03** Hrs.	**Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100**	Total No.of Contact Hours:**40**
Category	**PCC**	
Pre-requisites	**Engineering Physics, DOM**	

Course learning objectives:

- To understand the different chassis design & main components of automobile
- To understand the working of transmission and control system employed in automobiles
- To understand the automotive pollution and alternative automotive technologies under trail
- To understand the upcoming electric vehicle technology

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION TO AUTOMOBILES**	**10**
	Automotive Chassis Layout, Frame and body Construction, I.C. Engine Construction and Components. Engine Cooling and Lubrication System, Fuel Supply System for petrol and diesel Engine, Ignition System, Clutches, Transmission System, Drive Line System, Steering System, Suspension and Shock Absorber System, Braking System, Automotive Electrical System, Maintenance, Engine Testing, Servicing and Repair.	
UNIT-2	**TRANSMISSION & SUSPENSION SYSTEM**	**10**
	Clutches; Plate Clutches, Cone Clutch, Centrifugal Clutch, Fluid Flywheel Gear Box; Gear Shifting mechanism, synchromesh Gear box, Torque converter, Automatic Manual Transmission (AMT), Automatic Transmission (AT), intelligent manual Transmission (IMT) Continuously Variable Transmission (CVT), Infinitely Variable Transmission (IVT)- Working of Differential, Rear Axle types &construction. Suspension – layout & working of Hydraulic& Air suspension, Independent suspension, Functions& advantages of Leaf Spring, Coil Spring, Telescopic Shock Absorber, Torsion Bar	
UNIT-3	**CONTROL & SAFETY SYSTEMS**	**10**
	Steering system- mechanisms & Linkages, Steering gear boxes- Rack & pinion, worm & wheel construction &working,, power Steering construction & working, steering geometry, Wheel balancing Braking System- Mechanism and Linkages; Mechanical Brakes, Hydraulic Brakes, Power Brakes, Parking brakes, ABS, Safety system – Safety measures in modern vehicle – safety frames – working of - air bags, seat belt, collapsible steering, spoilers, defoggers, fire safety measures in heavy vehicles, bullet proof vehicles	
UNIT-4	**AUTOMOTIVE EMISSION & ALTERNATE VEHICLES**	**10**
	Exhaust gas pollutants and their effects on environment, Emission norms, IC engine fuels types, extraction& availability,	

	BIO Fuels – Production and impact. Ethanol engines, CNG vehicles- operation, advantages& disadvantages, over view of Hydrogen - fuel cell vehicles, advantages & disadvantages, IC engine/ electric hybrid vehicles over view, layout, transmission & control system, solar powered vehicles- wind powered vehicles, super capacitors, supply rails	
UNIT-5	**ELECTRIC VEHICLES& STORAGE BATTERIES**	**12**
	Electric vehicles principle and components- layout of two & 4 wheeler, Motors used in Electric vehicles –types- over view of construction and working, power transmission & control system in Electric vehicles. Batteries –construction & working principle of Lead acid, nickel based, sodium based, Lithium & Metal Air batteries. Battery charging types and requirements, battery cooling, fire safety measures in EV vehicles	

Course outcome:

At the end of the course the student will be able to :

1. Understand the working of different systems employed in automobile
2. Analyse the limitation of present day automobiles
3. Evaluate the energy sources suitability
4. Apply the knowledge for selection of automobiles based on their suitability

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	3	1	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3
CO5	3	3	3	3	2	2	3	2	3	1	3	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										
3.Design Data Hand Book is permitted										

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2023-24
SEMESTER : SIXTH

Course Title	**MECHATRONICS AND MICROPROCESSORS (PROFESSIONAL ELECTIVE COURSES– 1)**	
Sub.Code:**21MET6044**	No. of Credits:**03 = 3:0:0 (L-T-P)**	No. of Lecture Hours/Week**:03**
Exam Duration: **03** Hrs.	**Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100**	Total No.of Contact Hours:**40**
Category	**PCC**	
Pre-requisites	**Engineering Physics, DOM**	

Course objective:

1. Substantiate the need for interdisciplinary study in technology education.
2. Understand the evolution and development of Mechatronics as a discipline.
3. Define various types of transducers used and understand analog to digital converter and Vice versa.
4. Applications of microprocessors in various systems and to know the functions of each Element.
5. Describe the operation of mechanical, electrical pneumatic and hydraulic actuators.
6. Identify main parts, hardware forms and internal architecture of PLC, Architecture of 8086.

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION TO MECHATRONIC SYSTEMS**	**08**
	Measurement and control systems Their elements and functions, Microprocessor based controllers-engine management system, automatic camera and automatic washing machine, Modelling, Mechanical system, Electrical system, Fluid system and Thermal system , Modelling electrical motor, Modelling chamber filled with Fluid, Modeling pneumatic actuator.	
UNIT-2	**ACTUATORS AND MECHANISM**	**08**
	Actuators Types and application areas, Electro mechanical Actuators, Dc motor, AC motor, Stepper motor, Fluid power actuator, piezo electric actuator, magnetostrictive actuator, Mechanical components in mechatronics, force, friction and lubrication, materials, mechanical behaviour of materials, mechanisms used in mechatronics, lever and four bar mechanisms, bearing, belt, chain, cam, slider crank, clutches etc. Signal Conditioning: Introduction to signal conditioning. The operational amplifier.	
UNIT-3	**REVIEW OF TRANSDUCERS AND SENSORS**	**08**
	Definition and classification of transducers. Definition and classification of sensors. Principle of working of and applications of light sensors, proximity sensors – magnetic switch, eddy current type, pneumatic type, ultrasonic type and Hall effect sensors, Computing elements in mechatronics, analog computer, timer, analog to digital converter, digital to analog converter, digital computer, microprocessor and its architecture, micro-controllers, programming logic controllers, their basic structures, mnemonics.	
UNIT-4	**INTRODUCTION TO MICROPROCESSORS**	**08**

	Evolution of Microprocessor, Organization of Microprocessors (Preliminary concepts), basic concepts of programming of microprocessors. Review of concepts - Boolean algebra, Logic Gates and Gate Networks, Binary & Decimal number systems, memory representation of positive and negative integers, maximum and minimum integers. Conversion of real, numbers, floating point notation, representation of floating point numbers, accuracy and range in floating point representation, overflow and underflow, addition of floating point numbers, character representation. Central Processing Unit of Microprocessors**:** Introduction, timing and control unit basic concepts, Instruction and data flow, system timing, examples of INTEL 8086 and 4004 register organization.	
UNIT-5	**DATA WORD REPRESENTATION**	**07**
	Data word representation. Basic elements of control systems 808SA processor architecture terminology such as CPU, memory and address, ALU, assembler data registers, Fetch cycle, write cycle, state, bus, interrupts. Micro Controllers. Difference between microprocessor and micro controllers. Requirements for control and their implementation in microcontrollers. Classification of micro controllers. Organization & Programming of Microprocessors**:** Introduction to organization of INTEL 8086-Data and Address buses, Instruction set & programming of 8086.	

TEXTBOOKS:

1. A Kuttan, "Introduction to Mechatronics, Oxford University Press, 2010.
2. Alciatore & Histand, "Introduction to Mechatronics & Measurement Systems, 4e", McGrawHill Education, 2014.
3. M Jouaneh, "Fundamentals of Mechatronics", Cengage Learning, 2013.
4. W. Bolton, "Mechatronics", Pearson Education, Second Edition, 1999.Bradley
5. D. A., Dawson D., Buru N.C. and. Loader A.J, "Mechatronics", Chapman and Hall, 1993

REFERENCE BOOKS:

1. Dan Necsulesu, "Mechatronics", Pearson Education Asia, 2002 (Indian Reprint).
2. Nitaigour Premchand Mahadik, "Mechatronics", McGraw-Hill Education, 2015.
3. Lawrence J. Kamm, "Understanding Electro – Mechanical Engineering, An Introduction to Mechatronics", Prentice – Hall of India Pvt., Ltd., 2000.
4. Ramachandran K. P., Vijayaraghavan G. K., Balasundaram M.S. "Mechatronics: Integrated Mechanical Electronic Systems", Wiley.
5. Nitaigour Premchand Mahalik., Mechatronics principle, concept and applications. Tata McGraw- Hill Publishing company limited, New Delhi.

CO1: To understand the basic concepts of synergy between mechanical and electronic engineering concepts

CO2: To study various fundamental sensors required in automotive, aircraft etc used in all modes of transportation

CO3: To study the miniature electrical motors required in operation various mechanical machine components

CO4: To control the flow of current in required direction used in many applications

CO5: To write the architecture of various microprocessor which is applied in

computational machine

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	1	1	2	0	0	1	0	3
CO2	3	3	2	1	1	0	2	0	0	1	0	2
CO3	3	3	2	1	1	0	2	0	0	1	0	2
CO4	3	3	3	2	1	0	2	0	0	1	0	3
CO5	3	3	2	2	1	0	2	0	0	1	0	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)									
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2023-24
SEMESTER : SIXTH

Course Title	**THERMAL POWER PLANT (PROFESSIONAL ELECTIVE COURSE– 1)**	
Sub.Code:**21MET6045**	No. of Credits:**03 = 3:0:0 (L-T-P)**	No. of Lecture Hours/Week**:03**
Exam Duration:**03** Hrs.	**Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100**	Total No.of Contact Hours:**40**
Category	**PCC**	
Pre-requisites	**THERMODYNAMICS, POWER PLANT ENGINEERING**	

COURSE OBJECTIVES:

1. To understand the working of different types of boilers and other accessories of thermal plant and working,
2. To understand the working of different aspects of exhaust line of the thermal power station.
3. To understand the working feed water systems and cooling water systems in thermal plants.
4. To access the boiler performances and pollution and emissions in thermal plants.
5. To extend the studies on the me miscellaneous aspects of steam power plant

#	CONTENTS	Hrs
UNIT-1	**STEAM GENERATOR AND AUXILIARIES**	**08**
	High pressure boilers, classification, schemes¸ circulation, nature of fuels and its influence on design, furnaces, PF burners, PF milling plant, oil and gas burner types and location, arrangement of oil handling plant. Waste heat recovery systems. Operation and Maintenance of Steam Generators and auxiliaries: Pre commissioning activities, Boiler start up and shut down procedures, emergencies in boiler operation, Maintenance of Steam generator and auxiliaries.	
UNIT-2	**DUST EXTRACTION EQUIPMENT**	**08**
	Bag house, electrostatic precipitator, draught systems, FD, ID and PA fans, chimneys, flue and ducts, dampers, thermal insulation and line tracing, FBC boilers and types., waste heat recovery boilers.	
UNIT-3	**FEED WATER SYSTEM**	**08**
	Impurities in water and its effects, feed and boiler water corrosion, quality of feed water, boiler drum water treatment and steam purity, water treatment, clarification, demineralization, evaporation and reverse osmosis plant. Circulating water system: Introduction, System classification, The circulation system, Wet-Cooling towers, Wet-cooling tower calculations, Dry cooling towers, Dry-cooling towers and plant efficiency and economics, wet-dry cooling towers, cooling-tower icing, Cooling lakes and ponds, Spray ponds and canals	
UNIT-4	**PERFORMANCE OF BOILER**	**08**
	Boiler efficiency and optimization, coal mill, fans, ESP. EIA study: Pollutants emitted, particulate matter, SOx and NOx and ground level concentration, basic study of stack sizing.	

UNIT-5	MISCELLANEOUS OF STEAM POWER PLANT	08
	Methods of loading, plant selection, arrangements, useful life of plant components, pumps, cost estimation steam power plant, comparison of different power plants, current scenario of thermal power generation in India, Indian boiler act and amendments, case studies.	

Text books/ Reference books:

1. Turner, W. C., Doty, S. and Truner, W. C., Energy Management Hand book, 7th edition, Fairmont Press, 2009.

2. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.

3. Murphy, W. R., Energy Management, Elsevier, 2007.

4. Smith, C. B., Energy Management Principles, Pergamon Press, 2007

Course Outcomes:	
1	Understand the various energy conservation and improvement techniques.
2	Illustrate the Energy scenario
3	Employ the principles of thermal engineering and energy management to improve the Performance of thermal systems.
4	Assess energy projects on the basis of economic and financial criteria.
5	Describe methods of energy production for improved utilization

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	1	1	2	0	0	1	0	3
CO2	3	3	2	1	1	0	2	0	0	1	0	2
CO3	3	3	2	1	1	0	2	0	0	1	0	2
CO4	3	3	3	2	1	0	2	0	0	1	0	3
CO5	3	3	2	2	1	0	2	0	0	1	0	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2023-24
SEMESTER : SIXTH

Course Title	**FLUID MECHANICS AND MACHINES LABORATORY**	
Sub Code: 21MEL606	No of Credits: **1 = 0:0:2 (L-T-P)**	No. of Practical Hours/Week**:02**
Exam Duration:**03** Hrs	**CIE+SEE =50+50**	Total No. of Contact Hrs. : 13
Category	**PCL**	
Pre-requisites	**Fluid Mechanics, Turbomachines**	

COURSE OBJECTIVES:

1. To conduct experiment to determine coefficient of impact of water jet on vanes.
2. To determine coefficient of discharge of orifice meter, venturimeter and V-notch.
3. To conduct experiment to determine major loss of head in flow through a pipe.
4. To conduct performance test on Pelton, Francis and Kaplan turbines and evaluate the efficiency of these turbines.
5. To determine the efficiency of single stage and multi stage centrifugal pump and plot the characteristic curves; to conduct performance test on reciprocating pump and determine the percentage slip.

#	CONTENTS	Hrs.
UNIT-1	**MINOR EXPERIMENT**	**10**
	1) Impact of jet on vanes - Determination of coefficient of impact of water jet on flat vane, inclined vane and hemispherical vane. 2) Orifice meter – Determination of coefficient of discharge (Calibration of orifice meter) 3) Venturimeter – Determination of coefficient of discharge (Calibration of venturimeter) 4) V- notch – Determination of coefficient of discharge (Calibration of V notch) 5) Flow through a pipe - Determination of major losses.	
UNIT-2	**MAJOR EXPERIMENT**	**12**
	I. Performance testing, plotting the characteristic curves and determination of unit quantities and specific speed of 1) Pelton turbine 2) Francis turbine 3) Kaplan turbine **II.** Performance testing, plotting the characteristic curves and determination of specific speed of 4) Single stage centrifugal pump 5) Multi stage centrifugal pump **III.** Coefficient of discharge and percentage slip of a reciprocating pump.	

REFERENCE BOOKS

1) **Hydraulics and Fluid Mechanics including Hydraulic Machines**, Dr. P.N. Modi and S.M. Seth, Rajsons Publications Private Limited, Standard Book House, 2009.

COURSE OUTCOMES: After completion of the course, students will be able to:

CO1: Determine the coefficient of impact of jet on flat, inclined and hemispherical vanes.

CO2: Conduct the experiments on orifice meter, venturimeter and V-notch to calibrate them and determine their coefficient of discharge; determine the loss of head due to friction in pipes of different diameters.
CO3: Demonstrate the working of Pelton, Francis and Kaplan turbines and plot their operating characteristic curves by conducting performance test on them.
CO4: Conduct the performance test on single and four stage centrifugual pumps to plot their characteristic curves.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	3	1	1	1	1	1	1	1	1	1
CO2	1	1	3	1	1	1	1	1	1	1	1	1
CO3	1	1	3	1	1	1	1	1	1	1	1	1
CO4	3	3	1	1	1	1	1	1	1	1	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

SCHEME OF EXAMINATION (SEE)					
Sl. No.	**Particulars**	**Max. Marks**	**Break Up of Max. Marks**		
			Write Up	**Conduction of experiment**	**Specimen Calculation, Tabulation of Results and Plotting of Graph**
1	**Unit-1: Minor Experiment** (Any ONE from the list of experiments)	**15**	05	05	05
2	**Unit-2: Major Experiment** (Any ONE from the list of experiments)	**25**	05	10	10
3	Viva Voce	**10**	--	--	--
	TOTAL MARKS	**50**	**10**	**25**	**15**

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2023-24**
SEMESTER : SIXTH

Course Title	**MINI - PROJECT**	
Sub.Code:**21MEM607**	No. of Credits:**02 = 0:0:4 (L-T-P)**	**No. of contact hours/week : 04**
Exam Duration:**03** Hrs.	**Max. Marks: CIE +SEE = 100**	Total No.of Contact Hours:**39**
Category	**MP**	

COURSE OBJECTIVES:

1. To instill an atmosphere in students to find a working situation and discover the workable area.
2. To insure a transition from planned laboratory course to planning one independently.

CONTENTS
FABRICATION, MODELING & ANALYSIS
Students have to make simple projects with fabrication related to mechanical projects on a mini scale and/or projects using modeling and analysis tools project related to realistic problems of mechanical stream.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Literature review on national and international journals and define the problem.

CO2: Design Experiments scientifically / Perform Numerical Analysis / Develop Analytical models to Interpret the Results and Prepare quality document

MAPPING OF COs WITH POs												
COS/POS	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	1	2	1	1	1	1	2	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

SCHEME OF EXAMINATION (CIE)

1. Departments shall constitute a Departmental Project Review Committee (internal guide + faculty) to review the project at the middle of the semester.
2. Internal guide alone shall evaluate the project at the end of the semester for a maximum of 35 marks.
3. Project Review Committee shall evaluate the project at the end of the semester for a maximum of 15 marks.

SCHEME OF EVALUATION (CIE)			
Guide (MAX MARKS)	**PROJECT REVIEW COMMITTEE**		
	PARTICULARS	**(MAX MARKS)**	**TOTAL MARKS**
35	Relevance of topic	**05**	**50**
	Oral presentation	**05**	
	Viva Voce	**05**	
	TOTAL	**15**	

SCHEME OF VALUATION FOR SEE: Evaluation of the project by both internal and external examiners for a maximum of 50 marks by conducting project viva-voce.

SCHEME OF EVALUATION (SEE)		
Sl. No.	**Particulars**	**Max. Marks**
1	Relevance of the subject in the present context	**05**
2	Literature Survey	**05**
3	Problem formulation	**05**
4	Experimental observation / theoretical modelling	**05**
5	Results – Presentation & Discussion	**05**
6	Conclusions and scope for future work	**05**
7	Overall presentation of the Thesis/Oral presentation	**20**
	Total Marks	**50**

GUIDELINES FOR PREPARING PROJECT REPORT

1. Project reports should be typed neatly only on one side of the paper with 1.5 or double line spacing on an A4 size bond paper (210 x 297 mm).
2. **The margins should be:** Left – 1.25″, Right – 1″, Top and Bottom – 0.75″.
3. The total number of reports to be prepared are
   i) A copy to the department library
   ii) A copy to the concerned guide(s)
   iii) Two copies to the sponsoring agency
   iv) Candidate's copy.
4. Before taking the final printout, the approval of the **concerned guide(s) is mandatory** with suggested corrections, if any, to be incorporated.
5. For making copies dry tone Xerox is suggested. Every copy of the report must contain Inner title page (White) Outer title page with a plastic cover Certificate in the format enclosed both from the college and the organization where the project is carried out.
6. An **abstract (synopsis)** not exceeding 100 words, indicating salient features of the work. (NB: four copies of the abstract are to be submitted to the Department on the date of submission separately)
7. The organization of the report should be as follows
   i) Inner title page
   ii) Abstract or Synopsis
   iii) Acknowledgments
   iv) Table of Contents
   v) List of table & figures (optional)
   vi) Usually numbered in roman
   vii) Chapters (to be numbered in Arabic) containing Introduction-, which usually specifies the scope of work and its importance and relation to previous work and the present developments, Main body of the report divided appropriately into chapters, sections and subsections.
   viii) The chapters, sections and subsections may be numbered in the decimal form for e.g. Chapter 2, sections as 2.1, 2.2 etc., and subsections as 2.2.3, 2.5.1 etc.
   ix) The chapter must be left or right justified (font size 16). Followed by the title of chapter centered (font size 18), section/subsection numbers along with their

headings must be left justified with section number and its heading in font size 16 and subsection and its heading in font size 14. The body or the text of the report should have font size 12.

x) The figures and tables must be numbered chapter wise for e.g.: Fig. 2.1 Block diagram of a serial binary adder, Table 3.1 Primitive flow table, etc.

xi) The last chapter should contain the summary of the work carried, contributions if any, their utility along with the scope for further work.

xii) **Reference OR Bibliography:** The references should be numbered serially in the order of their occurrence in the text and their numbers should be indicated within square brackets for e.g. [3]. The section on references should list them in serial order in the following format.

For textbooks – A.V. Oppenheim and R.W. Schafer, Digital Signal Processing, Englewood, N.J., Prentice Hall, 3 Edition, 1975.

For papers – Devid, Insulation design to combat pollution problem, Proc of IEEE, PAS, Vol 71, Aug 1981, pp 1901-1907.

8. Only SI units are to be used in the report. Important equations must be numbered in decimal form for e.g.

$$V = IZ \text{ ……. } (3.2)$$

All equation numbers should be right justified.

9. The project report should be brief and include descriptions of work carried out by others only to the minimum extent necessary. Verbatim reproduction of material available elsewhere should be strictly avoided. Where short excerpts from published work are desired to be included, they should be within quotation marks appropriately referenced. Proper attention is to be paid not only to the technical contents but also to the organization of the report and clarity of the expression. Due care should be taken to avoid spelling and typing errors. The student should note that report-write-up forms the important component in the overall evaluation of the project
10. Hardware projects must include: the component layout, complete circuit with the component list containing the name of the component, numbers used, etc. and the main component data sheets as Appendix.
11. At the time of report submissions, the students must hand over a copy of these details to the project coordinator and see that they are entered in proper registers maintained in the department.
12. Software projects must include a virus free disc, containing the software developed by them along with the read me file. Read me file should contain the details of the variables used, salient features of the software and procedure of using them: compiling procedure, details of the computer hardware/software requirements to run the same, etc. If the developed software uses any public domain software downloaded from some site, then the address of the site along with the module name etc. must be included on a separate sheet. It must be properly acknowledged in the acknowledgments.
13. Sponsored Projects must also satisfy the above requirements along with statement of accounts, bills for the same dully attested by the concerned guides to process further, They must also produce NOC from the concerned guide before taking the internal viva examination.
14. The reports submitted to the department/guide(s) must be hard bounded, with a plastic covering.
15. Separator sheets, used if any, between chapters, should be of thin paper.

COLOUR OF THE OUTER COVER/FRONT PAGE OF UG DISSERTATION / PROJECT REPORT - SKY BLUE

Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY

(An autonomous institution, Aided by Govt. of Karnataka, Affiliated to VTU)
BDA Outer Ring Road, Near Jnana Bharathi Campus, Bengaluru - 560056

Aided By Govt. of Karnataka

Department of Mechanical Engineering

CERTIFICATE

Certified that the Mini project work (Sixth Semester) entitled…… is carried out by the following bonafide students of Mechanical Engineering in partial fulfillment for the award of Bachelor of Engineering, B. E (Mechanical) at **Dr. Ambedkar Institute of Technology, Bangalore,** during the academic year ..... .

Sl. No	U S N (ascending order)	Name of Student

It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the project report.

The project report has been approved satisfying the academic requirements prescribed for the said Degree.

Guide	**HOD**	**Principal**

External Viva:

Sl. No	Name of the examiner	Signature with date
1		
2		

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2023-24
SEMESTER : SIXTH

Course Title	**INNOVATION/ENTREPRENEURSHIP/ SOCIETAL INTERNSHIP**	
Sub.Code:**21MEI608**	No. of Credits:**03= 0:0:3 (L-T-P)**	**No. of contact hours/week : 03**
Exam Duration:**03** Hrs.	**Max. Marks: CIE +SEE = 100**	
Category	**INT**	

Dr. Ambedkar InstituteofTechnology,Bengaluru-560056
Outcome Based Education (OBE) and Choice Based Credit System(CBCS) (As per NEP 1 2020)
B.E. Mechanical Engineering
Tentative Scheme of Teaching and Examination effective from the Academic Year 2023-24

V Semester

Sl. No.	Course Category	Course Code	Course Title	Teaching Department (TD)/ Paper setting Board(PSB)	Teaching Hrs/ Week					Examination				Credits
					L	T	P	S	Total	Duration (Hrs)	CIE Marks	SEE Marks	Total Marks	
1	PCC	21MET501	Design of Machine Elements	Mechanical	3	0	0		03	03	50	50	100	3
2	IPCC	21MET502	Finite Element Methods & Analysis	Mechanical	3	0	2		05	03	50	50	100	4
3	PCC	21MET503	Computer Aided Design and Manufacturing	Mechanical	3	0	0		03	03	50	50	100	3
4	PCC	21MET504	Fluid Mechanics & Turbo Machines	Mechanical	3	0	0		03	03	50	50	100	3
5	PCC	21MEL505	Computer Aided Manufacturing Laboratory	Mechanical	0	0	2		02	03	50	50	100	1
6	AEC	21RMT506	Research Methodology & Intellectual Property Rights	TD: Any department PSB: As identified by the Institute	2	0	0		02	02	50	50	100	2
7	HSSC	21CVT507	Environmental Studies	TD: Civil/Chemistry PSB: Civil Engg.	1	0	0		01	01	50	50	100	1
8	AEC	21MET508X	Ability enhancement course – V	Concerned Board	If offered as Theory courses					01	50	50	100	1
					1	0	0							
					If offered as Lab Courses					02				
					0	0	2							
9	HSSC	21HSN509	Aptitude and Verbal ability skills		1	0	1	0		02	50	--	PP/ NP	0
										Total	450	400	800	18

Ability Enhancement Course-V			
Code	Course title	Code	Course title
21MET5081	Modelling and Simulation Lab		

Note: BSC: Basic Science Course, PCC: Professional Core Course, IPCC: Integrated Professional Core Course, AEC –Ability Enhancement Course INT – Internship, **HSSC:** Humanity and Social Science Courses.
L–Lecture, T –Tutorial,P-Practical/Drawing,S–SelfStudyComponent,CIE:Continuous Internal Evaluation, SEE: Semester End Examination.

Integrated Professional Core Course (IPCC): refers to Professional Theory Core Course Integrated with Practical of the same course. Credit for IPCC can be 04 and its Teaching – Learning hours (L:T:P) can be considered as (3:0:2) or (2:2:2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by CIE only and there shall be no SEE.
For more details the regulation governing the Degree of Bachelor of Engineering/Technology (BE/B.Tech.)2021-22 may be referred.

Dr. Ambedkar Institute of Technology, Bengaluru-560056
Outcome Based Education (OBE) and Choice Based Credit System(CBCS) (As per NEP 1 2020)
B.E. Mechanical Engineering
Tentative Scheme of Teaching and Examination effective from the Academic Year 2023-24

VI Semester

Sl. No.	Course Category	Course Code	Course Title	Teaching Department	Teaching Hrs/ Week					Examination				Credits
					L	T	P	S	Total	Duration (Hrs)	CIE Marks	SEE Marks	Total Marks	
1	HSSC	21MET601	Management & Entrepreneurship	Mechanical	3	0	0		3	03	50	50	100	3
2	IPCC	21MET602	Heat Transfer	Mechanical	3	0	2		3+2	03	50	50	100	4
3	PCC	21MET603	Mechanical Vibrations	Mechanical	3	0	0		3	03	50	50	100	3
4	PEC	21MET604X	Professional Elective course –I	Mechanical	3	0	0		3	03	50	50	100	3
5	OEC	21MET605X	Open Elective ɒurse- I		3	0	0		3	03	50	50	100	3
6	PCL	21MEL606	Fluid Mechanics and Machines Laboratory	Mechanical	0	0	2		2	03	50	50	100	1
7	MP	21MEM607	Mini Project		Two contact hours/week for interaction between the faculty and students					----	100	---	100	2
8	INT	21MEI608	Innovation/Entrepreneurship/ Societal internship	Completed during the intervening period of IV and V semesters.						----	100	----	100	3
9	HSSC	21HSN609	Analytical and reasoning skills	Placement cell	2	0	0	-	02	---	50	--	PP/ NP	0
Total											550	300	800	22

Note: HSSC: Humanity and Social Science Courses, **IPCC:** Integrated Professional Core Course, **PCC:** Professional Core Course, **EC:** Professional Elective Courses, O**EC**–Open Elective Course, **MP**–Mini Project, INT –Internship.
cture, **T**–Tutorial, **P**-Practical/Drawing, **S**–Self Study Component, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Examination.

Integrated Professional Core Course (IPCC): Refers to Professional Theory Core Course Integrated with Practical of the same course. Credit for IPCC can be 04 and its Teaching – Learning hours (L:T:P) can be considered as(3:0:2) or (2:2:2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by CIE only and there shall be no SEE. For more details, the regulation governing the Degree of Bachelor of Engineering/Technology(BE/) 2021-22 may be referred.

Professional Elective Courses(PEC):

A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course out of five courses. The minimum students strength for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the programme is less than10.

Open Elective Courses:

Students belonging to a particular stream of Engineering and Technology are not entitled for the open electives offered by their parent Department. However, they can opt an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/Advisor/Mentor.

Selection of an open elective shall **not be allowed** if,

(i) The candidate has studied the same course during the previous semesters of the program.

(ii) The syllabus content of open electives is similar to that of the Departmental core courses or professional electives.

(iii) A similar course under any category, is prescribed in the higher semester of the program.

In case, any college is desirous of offering a course (not included in the Open Elective List of the University) from streams such as Law, Business(MBA), Medicine, Arts, Commerce, etc., can seek permission, at least one month before the commencement of the semester, from the University by submitting a copy of the syllabus along with the details of expertise available to teach the same in the college.

The minimum students' strength for offering open electives is10.However, this conditional shall not be applicable to cases where the admission to The programme is less than 10.

Mini-project work: Mini Project is a laboratory-oriented course which will provide a platform to students to enhance the practical knowledge and skills by the development of small systems/applications.

Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini-project can be assigned to an individual student or to a group having not morethan4 students.

CIE procedure for Mini-project:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of project report, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project.

The CIE marks awarded for the Mini-project, shall be based on the evaluation of project report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

No SEE component for Mini-Project.

Professional Elective Courses-I		Open Elective Courses-I	
Subject Code	**Title**	**Subject Code**	**Title**
21MET6041	Inspection and Quality Control	21MET6051	Operations Research
21MET6042	Advanced Welding Processes	21MET6052	Energy and Environment Engineering
21MET6043	Modern Mobility & Automotive Mechanics	21MET6053	Engineering Economics
21MET6044	Mechatronics and Microprocessors	21MET6054	Product Design And Development
21MET6045	Thermal power plant		

Dr Ambedkar Institute of Technology, Bengaluru-56
Department of Mechanical Engineering

ADMISSION YEAR : 2022-23 **ACADEMIC YEAR: 2023-24**
SEMESTER : THIRD

Course Title	**MECHANICS OF MATERIALS**	
Sub Code: 22MET301	**No. of Credits: 3 = 3:0:0 (L-T-P)**	**No. of Lecture Hours/Week:03**
Exam Duration: 03 Hrs.	**Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100**	**Total No. of Contact Hours:40**
Category	**PCC**	
Pre-requisites	**Basic Engineering Mathematics**	

Course Learning Objectives:	
1	Understand the Mechanics of deformable bodies and apply them in analysis and design.
2	Evaluate the slope and deflection in beams subjected to different loading conditions.
3	Analyze a body subjected to two dimensional and three dimensional stress systems.
4	Interpret the torsional behavior of structural members. Assess the stability of columns and struts.
5	Examine the stresses in thin and thick cylinders subjected to loads.

UNIT No.	**Syllabus**	**No. of hours**	**BTLs**
1	**DEFORMATION, STRESSES AND STRAIN**	**08**	**L1-L4**
	Extension / Shortening of a bar, bars with cross sections varying in steps, bars with continuously varying cross sections (circular and rectangular), Elongation due to self-weight, Principle of super position. Stress in Composite Section. Volumetric strain, expression for volumetric strain, elastic constants, simple shear stress, shear strain, temperature stresses (including compound bars). Compound Stresses**:** Introduction, Plane stress, stresses on inclined sections, principal stresses and maximum shear stresses		
2	**BENDING MOMENT, SHEARING FORCE, BENDING AND SHEAR STRESSES IN BEAMS**	**08**	**L1-L4**
	Introduction, Types of beams, loads and reactions, shear forces and bending moments, rate of loading, sign conventions, relationship between shear force and bending moments. Shear force and bending moment diagrams for different beams subjected to concentrated loads, uniformly distributed load (UDL), uniformly varying load (UVL) and couple for different types of beams. Theory of simple bending, assumptions in simple bending. Bending stress equation, relationship between bending stress, radius of curvature, relationship between bending moment and radius of curvature. Moment carrying capacity of standard sections. Shearing stresses in beams, shear stress across Rectangular, circular, symmetrical I sections.		
3	**DEFLECTION OF BEAMS ,ENERGY METHODS, THEORIES OF FAILURE**	**08**	**L1-L4**

	Introduction, differential equation for deflection. Equations for deflection, slope and bending moment. Double integration method for cantilever and simply supported beams for point load, UDL, UVL and Couple. Macaulay's method. Energy Methods: Work, strain energy, Strain energy in bar/beams due to various loads. Maximum Principle Stress Theory, Maximum Shear Stress Theory, Distortion Energy Theory.		
4	**TORSION OF CIRCULAR SHAFTS & ELASTIC STABILITY OF COLUMNS and STRUTS**	**08**	**L1-L4**
	Introduction. Pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts. Power transmitted by solid and hollow circular shafts columns: Euler's theory for axially loaded elastic long columns. Derivation of Euler's load for various end conditions, limitations, Rankine's formula.		
5	**THICK AND THIN CYLINDERS**	**08**	**L1-L4**
	Stresses in thin cylinders due to internal pressure, circumferential stresses & longitudinal stresses. Deformation in thin cylinders, stresses due to internal pressure of thick cylinders, Lame's theory and numerical problems.		

Course Outcomes:	
1	Calculate stresses, strains applied to mechanical members under different loading and material properties.
2	Plot and analyze SFD and BMD of simply supported and cantilever beams for different types of loading and support conditions
3	Analyze Shear stresses in beams of different cross sections, analyze the deflection in beams and estimate the strain energy in mechanical elements.
4	Use torsion equation to calculate power transmission in shafts and analyze buckling and bending phenomenon in columns, struts and beams
5	Analyze and design thin, thick cylinders

Course Outcomes Mapping with Programme Outcomes & Programme Specific Outcomes.

Course Out Comes	**Level of CO**	**Program Outcomes**												**Programme specific outcomes**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1		3	3	3	3	2	0	0	0	0	0	2	0	3	0	0
CO2		3	3	3	3	2	0	0	0	0	0	2	0	3	0	0
CO3		3	3	3	3	2	0	0	0	0	0	2	0	3	0	0
CO4		3	3	3	3	2	0	0	0	0	0	2	0	3	0	0
CO5		3	3	3	3	2	0	0	0	0	0	2	0	3	0	0

Text Books.	
1	"Strength of Materials", S.S. Rattan, Tata ,Second Edition, McGraw Hill Education India
2	"Strength of Materials", S. Ramamrutham, Twentieth Edition

Reference Text Books.	
1	"Mechanics of Materials", James. M. Gere, Thomson, Fifth edition 2004.
2	"Mechanics of Materials", in S.I. Units, Ferdinand Beer & Russell Johnstan, TMH.
3	"Strength of Materials", S.S.Bhavikatti, Vikas pub. House -1 Pvt. Ltd., 2nd Ed., 2006.
4	“Advanced Mechanics of Solids”, L S Srinath, McGraw Hill Education India,2009

Web Links.
https://onlinecourses.nptel.ac.in/noc22_ce46/preview

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

Dr Ambedkar Institute of Technology, Bengaluru-56
Department of Mechanical Engineering

ADMISSION YEAR : 2022-23 **ACADEMIC YEAR: 2023-24**
SEMESTER : THIRD

Course Title	**MATERIAL SCIENCE AND METALLURGY**	
Sub Code: 22MEU302	**No. of Credits: 4 = 3:0:2 (L-T-P)**	No. of Lecture Hours/Week:**03** No. of Practical hours/week :**02**
Exam Duration: 03 Hrs.	**CIE+SEE=50+50=100**	**Total No. of Contact Hours:40 + 10 Lab Slots**
Category	**IPCC**	
Pre-requisites	**Engineering Physics & Chemistry**	

COURSE OBJECTIVES:

1. Know the fundamental science and engineering principles relevant to engineering materials.
2. Understand the intricacies involved in characterization, processing and design of materials.
3. Have the necessary theoretical and experimental skills for a pursuit in professional career.
4. Possess an intrinsic knowledge of the significance of different materials, the value of continued learning and environmental / social issues surrounding materials.
5. The student should be able to understand all basic principles involved in the application of materials for different engineering sectors.

#	CONTENTS	Hrs.
UNIT 1	**CRYSTAL STRUCTURES, MECHANICAL BEHAVIOUR AND PLASTIC DEFORMATION**	**8**
	Introduction to types of crystal structures, imperfection in solids, diffusion, stress-strain diagram showing ductile and brittle behaviour of materials, linear and nonlinear elastic behaviour and properties, mechanical properties in plastic region, yield strength, offset yield strength, ductility, malleability, ultimate tensile strength, toughness. Plastic deformation of single crystal by slip and twinning, strain hardening and strain aging, simple problems on stress and strain.	
UNIT 2	**FAILURE OF MATERIALS**	**8**
	Types of fracture, Griffith criteria for brittle fracture, distinguishing features of brittle and ductile fracture. Description of the creep phenomenon with examples, three stages of creep deformation and creep properties. Types of fatigue loading with examples, mechanism of fatigue, fatigue properties, fatigue testing and SN diagram.	
UNIT 3	**SOLIDIFICATION AND PHASE DIAGRAMS**	**8**
	Mechanism of solidification, homogenous and heterogeneous nucleation, crystal growth, cast metal structures. Solid solutions Hume Rothary rule, substitutional and interstitial solid solutions, intermediate phases and Gibbs phase rule. Types of phase diagrams, construction of equilibrium diagrams involving complete and partial solubility, lever rule, and simple problems on phase diagrams. Iron carbon equilibrium diagram, description of phases.	
UNIT 4	**HEAT TREATMENT, FERROUS AND NON-FERROUS ALLOYS**	**8**
	TTT curves, continuous cooling curves (CCT), Annealing and its types, normalizing, hardening, tempering, martempering, austempering, hardenability,	

	surface hardening methods like carburizing, cyaniding, nitriding, flame hardening and induction hardening. Steel and its classification, properties, composition and applications of Grey cast iron, malleable iron, Copper alloys-brasses and bronzes; Aluminum alloys-Al-Cu, Al-Si, Al-Zn alloys.	
UNIT 5	**COMPOSITE MATERIALS, SMART AND BIO MATERIALS**	**8**
	Composite materials: classification, properties, characteristics, and applications of PMCs, MMCs, CMCs and Carbon-Carbon Composites. **Smart Materials:** Smart materials–piezo-electric, shape memory alloys–Nitinol, superelasticity, Biological applications of smart materials-materials used as implants in human Body. **Biomaterials:** Introduction, Materials used as biomaterials, advantages, disadvantages and applications.	

Exp. No.	LIST OF EXPRIMENTS	No. of hours	BTLs
	PART - A		
1	Determine Young's modulus and plot a stress vs. strain diagram for a given mild steel specimen.	**26**	4
2	Determine the compression strength for a given cast iron specimen		4
3	Determine the shear strength by conducting a single shear test		
4	Determine the shear strength by conducting a double shear test		4
5	Determine the bending strength of the given Simply Supported Beam		4
6	Determine the modulus of rigidity of the given specimen by conducting torsion test		
	PART - B		
7	Determine the impact strength of a given specimen by conducting Izod test and Charpy tests		4
8	Fatigue Test		4
9	Brinell Hardness test, Rockwell Hardness test		4
10	Demonstration on Identification of microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass and Bronze		4
11	To study the defects of Cast and Welded specimens using Non-destructive test experiments like, (a) Magnetic crack detection (b) Dye penetration testing equipment		4

TEXT BOOKS:

1. Foundations of Materials Science and Engineering, Smith, 3rd Edition McGraw Hill, 2009
2. Materials Science, Shackleford and M. K. Muralidhara, Pearson Publication –2007.
3. Material Science, by Callister, Reprint 2008, Wiley India (P) LTD.
4. Material Science by V. Raghavan, Fifth Edition, PHI (P) LTD.
5. Introduction to Physical Metallurgy by Avner S H, 2nd Ed., MHP, 1985

6. Biomaterials, Sujata V. Bhat, Narosa Publishing House, 2002.

7. Smart Materials and Structures, M V Gandhi and B S Thompson Chapmen & Hall, London, 1992 (ISBN: 0412370107)

REFERENCE BOOKS:

1. Elements of Materials Science and Engineering, H. Van Vlack
2. Engineering Materials Science, W.C. Richards, PHI, 1965.
3. Physical Metallurgy; Lakhtin, Mir Publications.
4. Material Science and Engineering (SI Units), R.K. Rajput
5. Smart Materials and Structures, M V Gandhi and B S Thompson Chapmen &Hall
6. Material science and Metallurgy by K R Phaneesh, Sudha Publications-2005

Web Links.	
1	https://nptel.ac.in/courses/113102080
2	https://www.cet.edu.in/noticefiles/257_Basic%20Manufacturing%20Processes
3	https://nptel.ac.in/courses/manufactringprocess-1

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Differentiate crystal structures, imperfections, diffusion in solids, elastic and plastic properties of metal materials.
CO2: Analyze the various types of fracture, stages of creep and fatigue failure.
CO3: Describe mechanism of solidification, cast metal structure and rules for formation of solid solution.
CO4: Develop a capability to read a binary phase diagram and predict the properties that can be obtained by heat treatment and to know the characteristics and application of ferrous and nonferrous metals.
CO5: Know the physical and mechanical properties of composite materials also about the characteristics and applications of smart materials and biomaterials.

MAPPING OF COs WITH Pos												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	1	2	1	0	1	2	0	1	0	3
CO2	2	1	1	2	1	0	1	2	0	1	0	3
CO3	2	1	1	2	1	0	1	2	0	1	0	3
CO4	2	2	1	2	1	0	1	2	0	1	0	3
CO5	2	1	1	2	1	0	1	2	0	1	0	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

Assessment Details both (CIE and SEE)
The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass. **CIE:** The CIE has two components – CIE - theory component and CIE – laboratory component. Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE. Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.

CONTINUOUS INTERNAL EVALUATION (CIE)		**Max Marks**		**Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually)**
Theory	**Weightage of CIE1 and CIE2 Tests or CIE3**	**30**		**12**
Laboratory components	**Lab components:** Rubrics for each lab component are added, then taken average	**10**	**20**	**08**
	Lab CIE	**10**		
	TOTAL	**50**		**20**

CIE PATTERN		
Sl. No.	**Particulars**	**Max Marks**
Q 1	Any one question from Part -A	25
Q 2	Any one question from Part -B	15
Q 3	Viva Voice	10
Total		50 (Scale down to 10)

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2022-23 **ACADEMIC YEAR: 2023-24**
SEMESTER : THIRD

Course Title	**MANUFACTURING PROCESSES**	
Sub Code: 22MEU303	**No. of Credits: 4 = 3:0:2 (L-T-P)**	No. of Lecture Hours/Week:**03** No. of Practical hours/week :**02**
Exam Duration: 03 Hrs.	**CIE+SEE=50+50=100**	**Total No. of Contact Hours: 40 + 10 Lab Slots**
Category	**IPCC**	
Pre-requisites	**Elements of Mechanical Engineering**	

COURSE OBJECTIVES:

1. To expose the students to manufacturing techniques including their typical use and capabilities.
2. To teach the students mechanical aspects of manufacturing processes, such as casting, melting furnaces and welding and metal forming.
3. To provide students a technical understanding of cutting tools and conventional machine tools.
4. To teach the students mechanical aspects of manufacturing processes, such as surface finishing machine tools and non-traditional processes to aid in appropriate process selection for the material and required tolerances.
5. To give a knowledge of sand mold preparation and testing foundry sand.

#	**CONTENTS**	**Hrs.**
UNIT-1	**MOULDING MATERIALS, PROCESSES & MACHINES**	**08**
	Introduction to casting process & steps involved, components varieties produced by casting processes, advantages & limitations of casting processes, functions and materials used for patterns, types of binder used in molding sand, types of additives used and their properties, types of base sand, requirement of base sand, molding sand mixture, ingredients for different sand mixtures, method used for sand molding such as green sand, dry sand and skin dried moulds, sweep mold, CO2 mold, shell mold, flask less moulds, investment mould, Jolt type, Squeeze type, Jolt & Squeeze type and sand slinger, definition, need, types, method of making cores, binders used, core sand moulding, concept of gating and risering.	
UNIT-2	**CASTING PROCESSES & MELTING FURNACES, WELDING**	**08**
	Casting process: Gravity die-casting, pressure die casting, centrifugal casting, and continuous casting processes, casting defects, **Melting furnace:** constructional features & working principle of coke fired, oil fired and gas fired pit furnace, resistance furnace, coreless induction furnace, electric arc furnace, cupola furnace. **Welding:** Introduction, definition, principles, classification, application, advantages & limitations of welding, arc welding, metal arc welding (MAW), flux shielded metal arc welding (FSMAW), inert gas welding (TIG & MIG), resistance welding, seam welding, butt welding, spot welding and projection welding,	

	friction welding, explosive welding, thermit welding.	
UNIT-3	**MECHANICAL WORKING OF METALS, CUTTING TOOLS AND TOOL GEOMETRY**	**08**
	Mechanical working of metals: Introduction to metal forming processes & classification of metal forming processes, hot working & cold working of metals, smith forging, drop forging & press forging, forging equipment, defects in forging, rolling process, Types of rolling mills, variables of rolling process, rolling defects, drawing of wires, rods & pipes, variables of drawing process, difference between drawing & extrusion, various types of extrusion processes, blanking, piercing, and punching. **Cutting tools:** Cutting tools and tool geometry, types of cutting tools, tool materials-HSS, ceramics, cements, CBN & PCD, tool geometry and nomenclature , selection of tool materials and tool life, tool wear.	
UNIT-4	**MECHANICS OF METAL CUTTING AND MACHINE TOOLS**	**08**
	Mechanics of chip formation ,types of chips and conditions for the formation of each type built-up edge, its effects orthogonal Vs oblique cutting- merchant's force circle diagram, force and velocity relationship, shear plane angle, energy consideration in machining-ernst merchant theory of shear angle, relationship-original assumptions and modification made. **Lathe, Shaping, Planning and Slotting machine:** Classification, working principle, Different operations, work holding and tool holding devices on lathes, turret and capstan lathe, shaping machine, planning machine and slotting machines, mechanism, types of tools used. General and periodic maintenance of a center lathe. **Drilling and milling machine:** Classification, working principle, drilling related operations. Types of drill & drill bit nomenclature, drill materials, milling cutters nomenclature, milling operations, up milling and down milling concepts. Various milling operations. Indexing: Simple, compound, differential and angular indexing calculations. Principle of working, related operations and its applications, Simple problems on simple and compound indexing.	
UNIT-5	**GRINDING, BROACHING LAPPING HONING AND NON TRADITIONAL MACHINEING**	**08**
	Grinding, Broaching and Lapping machines: Types of abrasives, Grain size, bonding process, grade and structure of grinding wheels, grinding wheel types. Classification, constructional features of grinding machines (Centerless, cylindrical and surface grinding). Selection of grinding wheel, Grinding process parameters. Dressing and truing of grinding wheels. Principle of broaching. Details of a broach. Types of broaching machines-constructional details, applications, advantages and limitations. Principles, arrangement of set up and application. Polishing, buffing operation and application. **Non Traditional machining:** Classification, Mechanism of material removal,	

	Principle of working, process parameters, process capabilities, application, advantages and limitations of ECM, EDM, WEDM and USM.	

PARTS	LIST OF EXPRIMENTS	Hrs
PART - A	**SAND TESTING**	**10**
	1. To determine compression strength of a given molding sand specimen using universal sand testing machine. 2. To determine shear strength of a given molding sand specimen using universal sand testing machine. 3. To determine tensile strength of a given molding sand specimen using universal sand testing machine. 3. Conduct a permeability test on a given sand specimen to determine permeability of sand using permeability meter. 4. To determine grain fineness number of a given sand using sieve shaker. 5. To determine clay content in a given sand mixture using clay stirrer. 6. To determine hardness of a mold using hot air oven. 7. To determine hardness of a core using hot air oven.	
PART - B	**FOUNDRY MODELS**	**16**
	(i) Preparation of different shape of molds without using a patterns. (ii) Preparation of different shape of molds with using a patterns. (iii) Preparation of a casting (Aluminum or cast iron-Demonstration only) **NON DESTRUCTIVE TESTING FOR FORGING CASTING AND WELDING** Visual, Magnetic Particle, Dye Penetrant and Leak Testing.	

TEXT BOOKS:

1. "Manufacturing Process-I & II", Dr. K. Radhakrishna, Sapna Book House, 5thRevised Edition 2009.
2. "Manufacturing & Technology: Foundry Forming and Welding", P.N. Rao 2ndEd, TMH, 2003.
3. Manufacturing Science, Amitabha GhoshandMallik, affiliated East West Press,2003.
4. Metal Casting: Principles and Practice, T.V. RamanaRao,Published by NewAge International (P) Limited (2010)
5. Principles of Metal Casting, MahiSahoo , Sam Sahu , McGraw Hill Education (India) Private Limited; Third edition (26 September 2014)
6. Workshop Technology, Hajra Choudhry, Vol-II, Media Promoters & Pub. Pvt. Ltd. 2004
7. Production Technology, R.K.Jain, Khanna Publications, 2003.
8. Production Technology, HMT, Tata McGraw Hill, 2001.
9. Manufacturing Technology - Vol. 2, P N Rao, TMH Education; 3rd edition (1 May 2013)
10. Production Technology, P.C. Sharma, S Chand (1 December 2006)

REFERENCE BOOKS:

1. "Manufacturing Technology", SeropeKalpakjain, Steuen.R. Sechmid, PearsonEducation Asia, 5th Ed. 2006.
2. "Process and Materials of Manufacturing", Roy A Lindberg, 4thEd. PearsonEdu. 2006.
3. Principles of Metal Casting- Second Edition, Heine, Richard W.; CarlR. Loper, Jr. & Philip C. Rosenthal, Published by McGraw-Hill, New York (1967)
4. Mechanical Metallurgy Paperback, George E. DieterTMH.
5. Metal Forming: Mechanics and Metallurgy, Hosford,WF and Caddell,R.M, Published by Prentice Hall (1993)
6. Manufacturing Science, Amitabha Ghosh and Mallik, affiliated East West Press, 2003.
7. Fundamentals of Metal Machining and Machine Tools, G.Boothroyd, McGraw Hill, 2000
8. M C Shaw, Metal Cutting Principles, Oxford and IBH Publications, New Delhi (1969)

COURSE OUTCOMES: On completion of the course, student should be able to;

CO1: Explain different manufacturing process, patterns, cores, moulding sand constituents, moulding process and machines.
CO2: Discuss different casting processes, defects and melting furnaces.
CO3: Understand the principle of metal forming, tool materials and tool geometry.
CO4: Understand the mechanics of metal cutting and various traditional machine tools.
CO5: Understand the concepts metal finishing processes and non-traditional machining processes.

MAPPING OF COs WITH Pos												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	1	2	1	0	1	2	0	1	0	3
CO2	2	1	1	2	1	0	1	2	0	1	0	3
CO3	2	1	1	2	1	0	1	2	0	1	0	3
CO4	2	2	1	2	1	0	1	2	0	1	0	3
CO5	2	1	1	2	1	0	1	2	0	1	0	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

Assessment Details both (CIE and SEE)
The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass. **CIE:** The CIE has two components – CIE - theory component and CIE – laboratory component. Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE. Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.

CONTINUOUS INTERNAL EVALUATION (CIE)		**Max Marks**		**Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually)**
Theory	**Weightage of CIE1 and CIE2 Tests or CIE3**	**30**		**12**
Laboratory components	**Lab components:** Rubrics for each lab component are added, then taken average	**10**	**20**	**08**
	Lab CIE	**10**		
	TOTAL	**50**		**20**

CIE PATTERN		
Sl. No.	**Particulars**	**Max Marks**
Q 1	Any one question from Part -A	25
Q 2	Any one question from Part -B	15
Q 3	Viva Voice	10
	Total	50 (Scale down to 10)

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2022-23 **ACADEMIC YEAR: 2023-24**
SEMESTER : THIRD

Course Title	**BASIC THERMODYNAMICS**	
Sub Code: 22MET304	**No. of Credits: 03 =** **2:1:0 (L-T-P)**	**No. of Lecture Hours/Week:02** **No. of tutorial hours/week :02**
Exam Duration: 03 Hrs.	**Max. Marks : CIE+ Asmt +GA +** **SEE=40+5+5+50=100**	**Total No. of Contact Hours: 50**
Category	**PCC**	
Pre-requisites	**Engineering Chemistry, Physics, Mathematics**	

COURSE OBJECTIVES:

1. To understand the fundamental concepts of thermodynamic system, process and cycle.
2. To explain work and heat transfer with illustrations and examples.
3. To interpret first and second law of thermodynamics in the context of closed and open system.
4. To understand the concept of entropy and the principle of increase of entropy.
5. To solve problems related to thermodynamic system applying the various thermodynamic relations to pure substances and gases.

#	CONTENTS	Hrs.
UNIT-1	**FUNDAMENTAL CONCEPTS**	**7L+3T**
	Introduction to Thermodynamics, Macroscopic and microscopic viewpoint, thermodynamic system and control volume, thermodynamic property, process and cycle, thermodynamic equilibrium, quasi-static process, concept of continuum, thermostatics, units and dimensions; zeroth law of thermodynamics, temperature scales, types, comparison; Numerical Problems. Work transfer, pdV work – path function and point function, pdV work in various quasi-static processes, other types of work transfer, free expansion with zero work transfer, net work done by a system, heat transfer, heat transfer as a path function, specific heat and latent heat, comparison of heat and work transfer, Numerical Problems.	
UNIT-2	**FIRST LAW OF THERMODYNAMICS**	**7L+3T**
	Joule's experiment, First law of a closed system undergoing a cycle and undergoing a change of state, Internal energy as a property of a system, Modes of energy, specific heat at constatn volume and constant pressure, enthalpy, PMM 1, limitations of the first law, Numerical Problems. Application of first law to flow processes – control volume, steady flow process, mass and energy balance in a simple steady flow process, examples of steady flow processes -turbines, Compressor, Heat Exchangers, Centrifugal and reciprocating pumps, nozzles and diffusers, Numerical Problems.	

UNIT-3	**SECOND LAW OF THERMODYNAMICS AND ENTROPY**	**6L+4T**
	Cyclic heat engine, energy reservoirs, Kelvin-Planck and Clausius Statement of second law of thermodynamics, PMM 2, refrigerator and heat pump, equivalence of Kelvin-Planck and Clausius statements, reversibility and irreversibility, causes and conditions of irreversibility, carnot cycle, reversed heat engine, carnot's theorem and its corollary, Numerical Problems. Introduction, clausius theorem, The property of entropy, T-S plot, clausius inequality, entropy change in an irreversible process, entropy principle and its applications, Numerical Problems.	
UNIT-4	**AVAILABILITY AND PROPERTIES OF PURE SUBSTANCE**	**6L+4T**
	Availability, Irreversibility and General Thermodynamic relations. Introduction, Availability (Exergy), Unavailable energy, Relation between increase in unavailable energy and increase in entropy. Maximum work, maximum useful work for a system and control volume, irreversibility; Numerical Problems. Pure substances:P-V diagram and P-T diagram for a pure substance, p-v-T surface, T-s and h-s diagram for a pure substance, quality of pure substance, steam tables – saturation state, liquid-vapour mixture, compressed liquid, charts of thermodynamic properties, measurement of steam quality – throttling calorimeter, separating and throttling carlorimeter; Numerical Problems.	
UNIT-5	**IDEAL GASES AND REAL GASES**	**6L+4T**
	Ideal gases: Ideal gas mixtures, Daltons law of partial pressures, Amagat's law of additive volumes, evaluation of properties of perfect and ideal gases, Air- Water mixtures and related properties. Numerical Problems. Real gases – Introduction, Van-der Waal;s Equation of state, Van-der Waals constants in terms of critical properties, Beattie-Bridgeman equation, Law of corresponding states, Compressibility factor; compressibility chart. Difference between Ideal and real gases; Numerical problems.	

TEXT BOOKS

1.Engineering Thermodynamics, P.K. Nag, Tata McGraw Hill Education (India) Publications, 5th Edition, 2013.
2.Thermodynamics:An Engineering Approach, Yunus A. Cenegal and Michael A. Boles, McGraw-Hill Publications (SIE), 8th Edition, 2015.
3.A Text Book of Engineering Thermodynamics, R.K. Rajput, Laxmi Publishers, 3rd Edition, 2010.

REFERENCE BOOKS

1. Applications of Thermodynamics, V. Kadambi, T R Seetharam and K B Subramanya Kumar, Wiley India Private Limited, 1st Edition, 2019

2. Fundamentals of Thermodynamics, Claus Borgnakke and Richard E. Sonntag, Wiley Student Edition, 7th Edition, 2009.

3. Fundamentals of Engineering thermodynamics by H . N. Shapiro & M J Moran.

e-LEARNING RESOURCES

1. Videos and Lecture Notes: http:// www.nptel.ac.in

DATA HAND BOOK

1. Thermodynamics Data Book, B T Nijaguna and B S Samaga, Sudha Publishers, 2016.

Course Outcomes:	
1	Explain the concept of thermodynamic system and its interaction with surroundings, Zeroth law and Temperature concepts differentiate work and heat transfer in various Quasi Static thermodynamics processes; and solve related numerical problems (BL 1, 2, 3)
2	Interpret the first law of thermodynamics applied to a thermodynamic system and a flow process; and solve related numerical problems (BL 1, 2, 3).
3	Understand the Kelvin-Planck and Clausius statements of second law of thermodynamics; understand the concept of entropy principle and its applications to thermodynamic processes; summarize thermodynamic relations; and solve related numerical problems (RBTL 1, 2, 3).
4	Understand the concept of availability and irreversibility; understand various thermodynamic property diagrams for a pure substance; use the steam tables; (RBTL 1, 2, 3)
5	Discuss ideal and real gases; and solve related numerical problems (RBTL 1, 2, 3)

(BL: Revised Bloom's Taxonomy Level 1 – Remember, 2 – Understand, 3 – Apply, 4 - Analyze, 5 - Evaluate, 6 - Create)

Course Outcomes Mapping with Programme Outcomes & Programme Specific Outcomes.

Course Out Comes	**Level of CO**	**Program Outcomes**												**Programme specific outcomes**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1		3	3	3	0	0	0	2	1	1	1	0	1	3	0	0
CO2		3	3	2	0	0	0	2	1	1	1	0	1	3	0	0
CO3		3	3	3	0	0	0	2	1	1	1	0	1	3	0	0
CO4		3	3	3	0	0	0	2	1	1	1	0	1	3	0	0
CO5		3	3	3	0	0	0	2	1	1	1	0	1	3	0	0

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

Dr Ambedkar Institute of Technology, Bengaluru-56
Department of Mechanical Engineering

ADMISSION YEAR : 2022-23 **ACADEMIC YEAR: 2023-24**

SEMESTER : THIRD

Course Title	**COMPUTER AIDED MACHINE DRAWING**	
Sub Code: 22MEL305	**No. of Credits: 1 = 0:0:2 (L-T-P)**	**No. of Practical hours/week :02**
Exam Duration: 03 Hrs.	**Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100**	**Total No. of Contact Hours: 26**
Category	**PCC Lab**	
Pre-requisites	**Computer Aided Engineering Drawing, Solid Works Software**	

Course Learning Objectives:	
1	To apply drawing conventions and link design content
2	To sketch appropriate sectional views to communicate information about machine parts
3	To sketch different thread forms to understand thread terminology
4	To sketch different joints using principles of rivets
5	To create geometric models of mechanical parts and assemblies using CAD tool showing all parts in their operational positions

Dra No.	**Details of Drawing**	**No. of hours**	**BTLs**
	UNIT 1		
1	**Introduction to Solid Work 3D Tools: Introduction** to tools, and Sketching, Create Geometric Shapes, Basic part modelling, Assembly modelling tools.	**10**	**L1-L4**
2	**Sections of Solids:** Sectioning, Sectional views, representation of section plane, hatching, sectioning of engineering objects when the axis is inclined to one plane and parallel the other plane of projection – square, pentagonal, hexagonal prisms and pyramids, cylinder & cone.		**L1-L4**
	UNIT 1I		
3	**Thread Forms:** Thread terminology, sectional view of threads, ISO Metric (Internal & External), BSW (Internal & External), Square and Acme, Sellers thread, American Standard Thread, Helical thread inserts	**10**	**L1-L4**
4	**Rivets:** Single and double riveted lap joints, butt joints with single/double cover straps (chain and zigzag, using snap head rivets).		**L1-L4**
5	**Assembly of Joints (with GD&T) using 2D Environment:** Cotter Joint (socket & spigot), Knuckle Joint (pin joint)		**L1-L4**
6	**Assembly of Couplings (with GD&T) using 2D Environment:** Flanged coupling, universal coupling		**L1-L4**
	UNIT 1II		
7	**Assembly of Lifting Devices (with GD&T) using 3D Environment:** Screw Jack (Bottle Type)	**6**	**L1-L4**
8	**Assembly of I.C. Engine Components (with GD&T) using 3D Environment:** Connecting Rod		**L1-L4**

9	**Assembly of Bearings (with GD&T) using 3D Environment:** Plummer Block		**L1-L4**

Text Books.	
1	Solid works 2020 and Engineering Graphics by Randy H Shih, SDC Publications, 2020

Web Links.	
1	https://grabcad.com/library/software/solidworks
2	https://my.solidworks.com/training/catalog
3	https://www.solidprofessor.com/tutorials/solidworks

Course Outcomes:	
1	To select appropriate dimensions, tools to create parts.
2	To sketch the sectional views to analyse the interior of the machine assembly
3	Create the assembly of machine parts using CAD tool.

Course Outcomes Mapping with Programme Outcomes & Programme Specific Outcomes.

Course Out Comes	Level of CO	Program Outcomes												Programme specific outcomes		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	3	3	3	0	0	0	0	0	0	0	2	0	1	0	0
CO2	2	3	3	3	0	0	0	0	0	0	0	2	0	1	0	0
CO3	**3**	3	3	3	0	0	0	0	0	0	0	2	0	1	0	0

CONTINUOUS INTERNAL EVALUATION (CIE)

1. CIE has a maximum of 50 marks
2. All the drawings should be drawn in the class using Solid edge software. Sheet sizes should be A4. All sheets must be submitted at the end of the class by taking printouts.
3. CIE Marks is finalized by conducting a test at the end of 10th week of the semester
4. CIE Marks (50) = Evaluation of Record (Sketch -15 and Printout -15) + Test (20)

QUESTION PAPER PATTERN (SEE)							**TOTAL MARKS**
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	
UNIT	1		2		3		
MARKS	10		10		30		**50**
1. Two full questions (each of 10 Marks from Unit I and Unit II) are to be set from each unit. 2. Two full questions (each of 30 Marks from Unit III) are to be set from unit III.							
3. Student shall answer totally three full questions selecting one full question from each unit.							

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ADMISSION YEAR : 2022-23 **ACADEMIC YEAR: 2023-24**
SEMESTER: THIRD

Course Title	**ELECTRIC AND HYBRID VEHICLE TECHNOLOGY**	
Sub Code: 22MET306A	**No. of Credits: 3 = 3:0:0 (L-T-P)**	**No. of Lecture Hours/Week:03**
Exam Duration: 03 Hrs.	**Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100**	**Total No. of Contact Hours:40**
Category	**ESC**	
Pre-requisites	**Automobile engineering, Composite materials**	

Course Learning Objectives:	
1	To help students be thorough with the concepts of Electric vehicles (EVs) and its advantages to traditional ICE vehicles in the longer run.
2	To allow students to learn the basic structure of an EV and Hybrid Vehicles.
3	To provide insights into the electric motors and allied accessories that are essential for proper functioning of an EV system.
4	To enable students to learn to synthesize and characterize high performance nano materials for Li battery application. To enable students to design and assemble battery components and test them.
5	To help students understand the challenges and opportunities present in Battery thermal Management systems.

UNIT No.	**Syllabus**	**No. of hours**	**BTLs**
1	**CONVENTIONAL IC ENGINE - ELECTRIC VEHICLE**	**08**	**L1-L2**
	Limitations and environmental impact Introduction to Electric Vehicles: EV System, EV History, Electric Vehicles and the Environment, EV Advantages, EV Market, Usage Patterns for Electric Road Vehicles Types of Electric Vehicles– EV Architecture: Battery Electric Vehicles, IC Engine/Electric Hybrid Vehicle, Fuelled EVs, EVs using Supply Lines, EVs which use Flywheels or Super capacitors, Solar-Powered Vehicles, Vehicles using Linear Motors, EVs for the Future.		
2	**INTRODUCTION TO HYBRID VEHICLES**	**08**	**L2-L3**
	Types of hybrid vehicles, Hybrid electric vehicle, series and parallel HEV's, merits and Demerits of hybrid electric vehicles. Performance of Electric vehicles, Tractive effort and energy consumption in normal driving, regenerative braking, drive cycles: simple and standard, Numericals on electric performance.		
3	**ELECTRIC VEHICLE POWER TRAIN**	**08**	**L2-L3**
	Brief outline of electric motor, battery pack, invertor, charger and convertor, Electric Motors- AC/DC Motors/ Generators, Brushed DC Motor/Brushless DC Motor – Torque Characteristics, motor layout, torque vectoring, switched reluctance motors, induction motors, Basics of EV suspension.		

4	**BATTERIES**	**07**	**L2**
	Types, Lithium-ion battery-materials, current trend, battery charging and discharging cycles, use of batteries in powertrain. Battery management system (BMS): Introduction, Illustration of BMS battery pack capacity and range, Battery state evaluation: State of charge (SOC), State of health (SOH), State of Life (SOL).		
5	**BATTERY THERMAL MANAGEMENT SYSTEMS**	**08**	**L3**
	Thermal Issues of Li-ion battery, Operating Requirements, Overall Heat Transfer Co-efficient, Phase Change Material (PCM), Technologies of BTMS, Evaluation of Different Technologies, Modelling of BTMS.		

Text Books.	
1	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles , Ehsani, CRC Press, 1st edition / 2019
2	Electrical Vehicle Technology, Sunil R. Pawar, Notion Press Media Pvt Ltd, 2nd edition / 2021
3	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design , M. Ehsani, Y. Gao, S. Gay and Ali Emadi, CRC Press 2005

Reference Text Books.	
1	Electric and Hybrid Vehicles: Design Fundamentals , Iqbal Husain, CRC Press 2003

Web Links.	
1	https://onlinecourses.nptel.ac.in/noc23_ee01/preview

Course Outcomes Mapping with Programme Outcomes & Programme Specific Outcomes.

Course Out Comes	**Level of CO**	**Program Outcomes**												**Programme specific outcomes**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1		3	2					1			2		2	2	2	2
CO2		3	2					1			2		2	2	1	1
CO3		3	2					1			2		2	2	2	2
CO4		3	2					1			2		2	2	2	2
CO5		3	2					1			2		1	2	1	1

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

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ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2022-23
SEMESTER : THIRD

Course Title	**INDUSTRY 4.0**	
Sub Code: 22MET308A	**No. of Credits: 1 = 1:0:0 (L-T-P)**	**No. of Lecture Hours/Week:01**
Exam Duration: 03 Hrs.	**CIE+SEE=50+50=100**	**Total No of Contact hours: 13**
Category	**AEC**	
Pre-requisites	**Automobile engineering, Composite materials**	

Course Learning Objectives:	
1	Understand fundamentals of Industry 4.0
2	Understand tools for implementation of Industry 4.0
3	Get insights on its applications in the business world
4	Gain deep insights into how smartness is being harnessed from data
5	Appreciate what needs to be done in order to overcome some of the challenges.

UNIT No.	**Syllabus**	**No. of hours**	**BTLs**
1	**Introduction to Industry 4.0**	**02**	
	Introduction, core idea of Industry 4.0,origin concept of industry 4.0,Industry 4.0 production system, current state of industry 4.0, Technologies, How is India preparing for Industry 4.0.		
2	**A Conceptual Framework for Industry 4.0**	**02**	
	Introduction, Main Concepts and Components of Industry 4.0, State of Art, Supportive Technologies, Proposed Framework for Industry 4.0.		
3	**Technology Roadmap for Industry 4.0**	**03**	
	Introduction, Proposed Framework for Technology Roadmap, Strategy Phase, Strategy Phase, New Product and Process Development Phase.		
4	**Advances in Robotics in the Era of Industry 4.0**	**03**	
	Introduction, Recent Technological Components of Robots- Advanced Sensor Technologies, Internet of Robotic Things, Cloud Robotics, and Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications- Manufacturing, Maintenance and Assembly		
5	**The Role of Augmented Reality in the Age of Industry 4.0**	**03**	
	Introduction, AR Hardware and Software Technology, Industrial Applications of AR. **Obstacles and Framework Conditions for Industry 4.0:** Lack of A Digital Strategy alongside Resource Scarcity, Lack of standards and poor data security, Financing conditions, availability of skilled workers, comprehensive broadband infra- structure, state support, legal framework, protection of corporate data, liability, handling personal data.		

Text Books	
1	Industry 4.0: Managing The Digital Transformation, Alp Ustundag, Emre Cevikcan, 2017, Springer, ISBN 978-3-319-57869-9 ISBN 978-3-319-57870-5
2	The Concept Industry 4.0 - An Empirical Analysis of Technologies and Applications in Production Logistics, Christoph Jan Bartodziej, 2017, Springer Gabler, ISBN 978-3-658-16501-7 ISBN 978-3-658-16502-4
3	Industry 4.0 - The Industrial Internet of Things, Alasdair Gilchrist, 2016, APRESS, ISBN-13 978-1-4842-2046-7 ISBN-13 978-1-4842-2047-4
4	Digitizing the Industry – Internet of Things connecting the Physical, Digital and Virtual Worlds, Ovidiu Vermesan, 2016, River Publishers, ISBN 978-87-93379-81-7 ISBN 978-87-93379-82-4

Course Outcomes:	
1	Explain the importance of Industry 4.0
2	Identify the conceptual Framework for Industry 4.0.
3	Identify the technology Roadmap for Industry 4.0
4	Advances in Robotics in the Era of Industry 4.0
5	Compare the Role of Augmented Reality in the Age of Industry 4.0 and Obstacles and Framework Conditions for Industry 4.0

Course Outcomes Mapping with Programme Outcomes & Programme Specific Outcomes.

Course Out Comes	Level of CO	Program Outcomes												Programme specific outcomes		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1		3	3	1	2								3			
CO2		3	3	2	2	1							2			
CO3		3	2	2		1							1			
CO4		3	2	2		2	2	1	1	1		2	2			
CO5		3	2	2	3	2	1	1	2	2	2	2	2			

SCHEME FOR EXAMINATIONS

Pattern of question paper is MCQ (1 mark each).

CIE paper will be 25 objective type questions each of 1 mark

SEE paper will be 50 objective type questions each of 1 mark.

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ADMISSION YEAR : 2022-23 **ACADEMIC YEAR: 2023-24**
SEMESTER : FOURTH

Course Title	**THEORY OF MACHINES**	
Sub Code: 22MET401	**No. of Credits: 3 = 3:0:0 (L-T-P)**	**No. of Lecture Hours/Week:03**
Exam Duration: 03 Hrs.	**Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100**	**Total No. of Contact Hours:40**
Category	**PCC**	
Pre-requisites	**Basic Engineering Mathematics, Engineering Mechanics**	

Course Learning Objectives:	
1	To identify and enumerate different link based mechanisms with basic understanding of motion.
2	To construct, analyze and interpret the velocity and acceleration of simple mechanisms by relative and instantaneous centre methods.
3	To analyze and interpret static and dynamic forces in mechanisms graphically.
4	To interpret and solve balancing of rotating masses under static and dynamic loading and identify and elucidate different types of governors and their terminologies.
5	To analyze and develop cam profiles for different followers

UNIT No.	**Syllabus**	**No. of hours**	**BTLs**
1	**LINKS & MECHANISMS, FRICTION**	**07**	**L1-L3**
	Definitions Link or Element, Kinematic Pairs, Grubler's Criterion Kinematic Chain, Different types of Mechanism, Difference between Structure and Machine, Mobility of Mechanism to identify degrees of freedom. Kinematic Chains and Inversions: Inversions of Four Bar Chain; Single Slider Crank Chain and Double Slider Crank Chain. Toggle Mechanism Friction: Definitions: Types of friction: laws of friction, different types of bearings, Friction in ball bearings.		
2	**VELOCITY AND ACCELERATION ANALYSIS OF MECHNISMS**	**09**	**L1-L3,L4**
	Slider crank mechanism and simple mechanisms by vector polygons: relative velocity and acceleration of particles in a common link, relative velocity and accelerations of coincident particles on separate links-Coriolis component of acceleration, Angular velocity and angular acceleration of links, Numericals. Definition of Kennedy's Theorem, determination of linear and angular velocity using Instantaneous Center Method, Numericals. Using Klein's Construction Analysis of velocity and acceleration of single slider crank mechanism, Numericals.		
3	**STATIC & DYNAMIC FORCE ANALYSIS**	**07**	**L1-L3,L4**
	Static force analysis: Introduction: Static equilibrium. Equilibrium of two and three force members. Members with two forces and torque, free body diagrams, principle of virtual work. Static force analysis of four bar mechanism and slider-crank mechanism with and without friction.		

	Dynamic force analysis of four-bar mechanism and slider crank mechanism. Force principle: Alembert's principle, Inertia force, inertia torque, Numericals		
4	**BALANCING OF ROTATING MASSES & GOVERNORS**	**08**	**L1-L3,L4**
	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. **Governors:** Types of governors; force analysis of Porter and Hartnell governors. Controlling force, stability, sensitiveness, isochronisms, effort and power. Numericals		
5	**CAMS**	**09**	**L1-L3,L4**
	Types of Cams, Types of Followers. Displacement, Velocity & Acceleration Time Curves for Cam Profiles. Disc Cam with Reciprocating Follower-Having Knife- Edge, Roller & Flat-Face Follower, Disc Cam With Oscillating Roller Follower. Follower Motions including-SHM, Uniform Velocity, Uniform Acceleration & Retardation and Cycloidal Motion, Numericals		

Text Books.	
1	"Theory of Machines", Rattan S.S, Tata McGraw-Hill Publishing Company Ltd., New Delhi, and 3rd Ed-2009
2	"Theory of Machines", Sadhu Singh, Pearson Education (Singapore) Pvt. Ltd, Indian Branch New Delhi, 2nd Ed 2006
3	"Theory Of Machines", R.S. Khurmi & J. K. Gupta, S Chand; 14th edition 2020

Reference Text Books.	
1	"Theory of Machines & Mechanisms", J.J. Uicker, G.R. Pennock, J.E. Shigley, OXFORD 3rd Ed. 2009.
2	"Mechanisms and Dynamics of Machinery" by J. Srinivas, Scitech Publications, Chennai, 2002.
3	"Theory of Machines" by Dr. V P Singh, 6th Edition January 2017

Web Links.	
1	https://nptel.ac.in/courses/112/106/112106270/

Course Outcomes:	
1	To calculate degrees of freedom in different mechanisms and analyze friction in mechanisms
2	To calculate the governor effort and controlling force, to draw the velocity and acceleration diagrams and to determine instantaneous centers in four bar and slider crank mechanisms
3	To analyze the static and dynamic forces in the four bar mechanisms
4	To balance the several masses and its position in same plane and different planes
5	To design cam profiles

Course Outcomes Mapping with Programme Outcomes & Programme Specific Outcomes.

Course Out Comes	Level of CO	Program Outcomes												Programme specific outcomes		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1		3	3	3	3	2	0	0	0	0	0	2	0	3	0	0
CO2		3	3	3	3	2	0	0	0	0	0	2	0	3	0	0
CO3		3	3	3	3	2	0	0	0	0	0	2	0	3	0	0
CO4		3	3	3	3	2	0	0	0	0	0	2	0	3	0	0
CO5		3	3	3	3	2	0	0	0	0	0	2	0	3	0	0

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

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ADMISSION YEAR : 2022-23 **ACADEMIC YEAR: 2023-24**
SEMESTER : FOURTH

Course Title	**MECHANICAL MEASUREMENTS**	
Sub Code: 22MEU402	**No. of Credits: 4 = 3:0:2 (L-T-P)**	No. of Lecture Hours/Week:**03** No. of Practical hours/week :**02**
Exam Duration: 03 Hrs.	**CIE+SEE=50+50=100**	**Total No. of Contact Hours:40 + 10 Lab Slots**
Category	**IPCC**	
Pre-requisites	**Engineering Physics, Basic Electrical Engineering**	

Course Learning Objectives:	
1	To provide no Explain the concepts of measurement and gauging instruments.
2	To provide knowledge on various metrological equipment's available to measure the dimension of the components.
3	To provide knowledge on the correct procedure to be adopted to measure the dimension of the components.
4	Explain and apply the principles in manufacturing industries
5	Calculate modulus of elasticity of a ductile specimen
6	Measurement of parameters like; Angle, Alignment, Cutting tool forces, Screw thread, Surface roughness and Gear tooth profile

#	CONTENTS	Hrs.
UNIT-1	**STANDARDS OF MEASUREMENT, LIMITS, FITS AND TOLERANCE**	**08**
	Standards of measurement: Definition and Objectives of metrology, standards of length- international prototype meter, imperial standard yard, wave length standard, subdivision of standards, line and end standard, calibration of end bars (Numerical), slip gauges, wringing phenomena, Indian standards (M-81, M-12), numerical problems on building of slip gauges. **Limits, fits and tolerance:** definition, need for limit systems, definition of fits, types of fits and their designation (IS919-1963), hole basis system, shaft basis system. definition of tolerance, principle of interchangeability and selective assembly ,concept of limits of size and tolerance specification in assembly, and tolerances, compound tolerances, accumulation of tolerances, geometrical tolerance, positional-tolerances.	
UNIT-2	**GAUGES AND LINEAR MEASUREMENTS**	**08**
	Gauges: Design of limit gauges by Taylor's principle, types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials wear allowance on gauges. **Linear Measurements:** introduction to comparators, characteristics,	

	classification of comparators, mechanical comparators-Johnson Mikrokator, sigma comparators, dial indicator, optical comparators- Mechanical-optical comparators, Zeiss ultra-optimeter, electric and electronic comparators- LVDT, pneumatic comparators, Velocity and back pressure type, solex comparator.	
UNIT-3	**ANGULAR MEASUREMENTS AND INTERFEROMETRY**	**08**
	Angular measurements: Bevel protractor, sine principle and use of sine bars, sine center, use of angle gauges (numerical on building of angles), and clinometers. Surface roughness-Straightness, flatness, perpendicularity, parallelism, roundness and cylindrical. **Interferometry**: Interferometer, autocollimator. Optical flats. Terminology of screw threads, profile projector- measurement of major diameter, minor diameter, pitch, angle and effective diameter of screw threads by 2-wire and 3-wire methods, tool maker's microscope, gear tooth, terminology, use of gear tooth vernier caliper and micrometer.	
UNIT-4	**MEASUREMENT AND MEASUREMENT SYSTEMS**	**08**
	Measurement: Definition, significance, accuracy, Resolution precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity, Errors, classification of errors. **Generalized measurement systems:** Transducers - transfer efficiency, primary and secondary transducers, electrical, mechanical, electronic transducers, advantages. Intermediate modifying devices - Mechanical systems, electronic amplifiers and telemetry. Terminating devices- cathode ray oscilloscope, oscillographs, X-Y plotters.	
UNIT-5	**FORCE, TORQUE, PRESSURE, TEMPERATURE AND STRAIN MEASUREMENT**	**08**
	Force measurement – Introduction, direct methods, indirect methods and Proving ring **Torque measurements-** Introduction, mechanical dynamometers, hydraulic dynamometers and electrical dynamometers. **Pressure measurements:** introduction**,** definition of pressure terms, methods of measuring pressure- pressure measurement with elastic transducers, Bridgeman gauge, McLeod gauge. **Temperature measurements:** Resistance thermometers, thermocouple, law of thermocouple, materials used for construction, pyrometer, optical pyrometer. **Strain measurements**, Wheatstone resistance bridge arrangement for strain measurement, gauge factor, mechanical strain gauge, Resistance strain gauge, Electrical strain gauge.	

Exp No.	LIST OF EXPRIMENTS	No. of hours	BTLs
1	Calibration of Pressure Gauge.	**26**	**4**
2	Calibration of LVDT		**4**
3	Calibration of Thermocouple and Load cell		**4**
4	Calibration of Micrometer and Vernier caliper using slip gauges		**4**
5	Determination of modulus of elasticity of a ductile specimen using strain gauges		**4**
6	Measurement of Various parameter using profile projector		**4**
7	Measurement using Optical Flats		**4**
8	Measurement of angle using Sine bar.		**4**
9	Measurement of angle using bevel protractor		**4**
10	Measurement of Gear tooth profile using gear tooth Vernier.		**4**

TEXT BOOKS:

1. Mechanical Measurements, Beckwith Marangoni and Lienhard, Pearson Education, 6th Edition, 2006. (For Measurements Only)
2. Engineering Metrology, R.K. Jain, Khanna Publishers, 1994. (For Metrology Only)

REFERENCE BOOKS:

1. Engineering Metrology, I.C. Gupta, Dhanpat Rai Publications, Delhi.
2. Mechanical Measurements, R.K. Jain
3. Industrial Instrumentation, Alsutko, Jerry. D. Faulk, Thompson Asia Pvt. Ltd.2002.
4. Measurement Systems Applications and Design, Ernest O. Doblin, McGraw Hill

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Describe different standards and the importance of standardization.
CO2: Recognize measurements necessity, various dimensional measurements.
CO3: Design measurement system for a given parameter
CO4: List the different kinds of sensors, transducers, and recorders.
CO5: Assess measurement system with its limitations.
CO6: Calibrate various measuring instruments and measurement of gear profile, angle and Surface roughness.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	0	0	1	1	1	1	2	0	2
CO2	3	3	2	0	0	1	1	1	1	1	0	2
CO3	3	3	2	0	0	1	1	1	1	2	0	2
CO4	3	3	2	0	0	1	1	1	1	2	0	2
CO5	3	3	3	0	0	1	1	1	1	1	0	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

Assessment Details both (CIE and SEE)
The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass. **CIE:** The CIE has two components – CIE - theory component and CIE – laboratory component. Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE. Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.

CONTINUOUS INTERNAL EVALUATION (CIE)		Max Marks		Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually)
Theory	**Weightage of CIE1 and CIE2 Tests or CIE3**	**30**		**12**
Laboratory components	**Lab components:** Rubrics for each lab component are added, then taken average	**10**	**20**	**08**
	Lab CIE	**10**		
TOTAL		**50**		**20**

CIE PATTERN		
Sl. No.	**Particulars**	**Max Marks**
Q 1	Any one question from list of experiments	40
Q 2	Viva Voice	10
Total		50 (Scale down to 10)

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

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ADMISSION YEAR : 2022-23 **ACADEMIC YEAR: 2023-24**
SEMESTER : FOURTH

Course Title	**APPLIED THERMODYNAMICS**	
Sub Code: 22MEU403	**No. of Credits: 4 =** **2:1:1 (L-T-P)**	No. of Lecture Hours/Week:02 No. of Tutorial Hours/Week:02 No. of Practical hours/week :02
Exam Duration: 03 Hrs.	**CIE+SEE=50+50=100**	**Total No. of Contact Hours:52 + 13 Lab Slots**
Category	**IPCC**	
Pre-requisites	**Basic Engineering Mathematics, Basic Engineering Thermodynamics**	

Course Learning Objectives:	
1	To relate the fundamentals of thermodynamics to the real time applications.
2	To describe the various thermodynamic power cycles which use air and vapour as the working fluid
3	To apply the fundamental concepts to derive various thermodynamic variables for solving numerical problems
4	To understand and determine the performance parameters of various thermodynamic systems.

UNIT No.	**Syllabus**	**No. of hours**	**RBTLs**
1	**AIR STANDARD POWER CYCLES**	**12**	**L1,L2,L3**
	Introduction; Description, work and heat transfers of various thermodynamic processes, p-v and T-s diagrams, Air standard cycles - derivation of efficiency and mean effective pressure of Carnot, Otto, Diesel, dual combustion and Stirling cycles; IC Engines – Combustion of SI and CI engines, Detonation and factors affecting detonation; Testing and performance of IC engines: basic measurements – engine speed, fuel consumption, air consumption, exhaust Smoke, IP, BP, FP measurements, heat balance sheet, Alternate Fuels.		
2	**GAS TURBINE CYCLES AND JET PROPULSION**	**10**	**L1,L2,L3**
	Introduction; Analysis of simple gas turbine cycle (Brayton cycle); Methods to improve the performance of gas turbine plant – efficiency of regenerative gas turbine cycle; Reheat gas turbine cycle; Gas turbine cycle with intercooling; Gas turbine cycle with reheat, regeneration and intercooling, Numerical problems; Jet Propulsion – Introduction to jet propulsion, Gas turbine cycles for jet propulsions, Working of ram jet engine, Pulse jet engine, Turbo jet engine, Turboprop engine, comparisons of various propulsive devices, Numerical problems.		
3	**VAPOUR POWER CYCLES**	**10**	**L1,L2,L3**
	Introduction; Carnot vapor power cycle; Rankine cycle; actual vapour power cycle; Comparison of Rankine and Carnot cycles; Mean temperature of heat addition; Steam nozzles - Flow of steam through		

	nozzles, Shape of nozzles, effect of friction, Critical pressure ratio, Supersaturated flow; Methods of improving the thermal efficiency of vapor power plant; Reheat cycle; Ideal and practical regenerative cycle; Reheat-regenerative cycle; feed water heaters; Numerical problems.		
4	**RECIPROCATING AIR COMPRESSORS**	**10**	**L1,L2,L3**
	Introduction; Working principle, p-v diagram and derivation of work input of a single stage reciprocating compressor; Adiabatic, isothermal and mechanical efficiencies; Effect of clearance and derivation of volumetric efficiency, Numerical problems; Multistage compressor; Intercooling, Saving in work, Optimum intermediate pressure, Minimum work for compression; Numerical problems.		
5	**REFRIGERATION CYCLES AND PSYCHROMETRY**	**10**	**L1,L2,L3**
	Introduction; Units of refrigeration, COP; Reversed Carnot cycle; Vapour compression refrigeration cycle; Deviation of actual cycle from ideal cycle; Effect of change in operating conditions on the performance of vapour compression cycle, Numerical problems; Refrigerants – Selection, Properties of refrigerant; Vapour absorption refrigeration system, Steam jet refrigeration system; Gas cycle refrigeration-Bell Coleman cycle; Numerical problems; Psychrometry: Definitions of terms related to psychrometry – WBT, DBT, DPT, specific humidity, relative humidity, enthalpy, psychrometric chart,		

LABORATORY WORK:

Exp No.	LIST OF EXPRIMENTS	No. of hours	RBTLs
	PART - A		
1	**MINOR EXPERIMENTS** Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Martin (closed) (or) Cleave land (Open Cup) Apparatus. Determination of Calorific value of solid, liquid and gaseous fuels. Determination of Viscosity of lubricating oil using Redwoods Saybolts and Torsion Viscometers. Valve Timing of a four stroke I.C. engine. Use of Planimeter.	**14**	**L4**
	PART – B		
2	**MAJOR EXPERIMENTS** Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiencies, SFC, FP, heat balance sheet for Four stroke Diesel Engine Four stroke Petrol Engine	**12**	**L4**

	Two stroke Petrol Engine Morse test to evaluate the friction power in Multi Cylinder Diesel/Petrol Engine		

Text Books.	
1	Basic and Applied Thermodynamics, P.K. Nag, Tata McGraw-Hill Publications, 2nd Edition, 2010.
2	Applications of Thermodynamics, V. Kadambi, T R Seetharam and K B Subramanya Kumar, Wiley India Private Limited, 1st Edition, 2019.
3	Thermodynamics: An Engineering Approach, Yunus A Cengel and Michael A Boles, McGraw Hill Education (India) Pvt. Limited, 8th Edition, 2016
4	Internal Combustion Engines, V Ganeshan, Tata McGraw-Hill Publications, 4th Edition, 2012.

Data Hand Books and Charts	
1	Thermodynamics Data Hand Book (SI Units), B T Nijaguna and B S Samaga, Sudha Publications, 2016.
2	Refrigeration Tables and Charts: SI Units, C.P. Kothandaraman, 4th Edition, New Age International Publishers, 2015.

Reference Text Books.	
1	A Course in Thermal Engineering, A. Domkundwar, C.P. Kothandaraman, S. Domkundwar, DanpatRai and Co (P) Limited, 2013.
2	Gas Turbines, V Ganeshan,Tata McGraw-Hill Publications, 2nd Edition, 2003.
3	Gas Turbines and Jet Rocket Propulsion, V.M. Domkundwar, DhanpatRai & Co.(P) Limited, 2nd Edition, 2013.

Web Links.	
1	Students are encouraged to visit http:// www.nptel.ac.in (http:// www.swayam.gov.in) and register for the following MOOCs: Concepts of Thermodynamics (12 Week Course; Jan-April/July-Oct) IC Engines and Gas Turbines (12 Week Course; Jan-April) Applied Thermodynamics for Engineers (12 Week Course; July-Oct)

Course Outcomes:	
1	Explain various thermodynamic processes and air standard power cycles with p-v and T-s diagrams; derive expressions of efficiency and mean effective pressure of power cycles; understand the measurement of various parameters to assess the performance of internal combustion engines (RBTL 1, 2, 3).
2	Describe the various gas turbine cycles and jet propulsion devices with neat sketches; solve related numerical problems (RBTL 1, 2, 3).
3	Understand and compare the Carnot and Rankine vapour power cycles with T-s diagrams;

	derive expressions for efficiency and solve related numerical problems (RBTL 1, 2, 3).
4	Describe the working principle of reciprocating air compressor; derive the expressions for its performance and solve related numerical problems (RBTL 1, 2, 3).
5	Explain the vapour compression and gas cycle refrigeration systems with T-s diagrams; derive expressions for coefficient of performance and solve related numerical problems; Describe the various psychrometric processes plotted on a psychrometric chart; understand the summer and winter air conditioning systems and solve related numerical problems (RBTL 1, 2, 3).

Course Outcomes Mapping with Programme Outcomes & Programme Specific Outcomes.

Course Out Comes	Level of CO	Program Outcomes												Programme specific outcomes		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1		3	3	2	2	0	1	2	2	3	3	3	3	3	0	0
CO2		3	3	3	2	0	1	2	2	3	3	3	3	3	0	0
CO3		3	3	2	2	0	1	2	2	3	3	3	3	3	0	0
CO4		3	3	3	2	0	1	2	2	3	3	3	3	3	0	0
CO5		3	3	2	2	0	1	2	2	3	3	3	3	3	0	0

Assessment Details both (CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) and Semester End Exam (SEE) is 50% each. The students have to obtain a minimum of 40% marks individually both in CIE and SEE to pass.

CIE: The CIE has two components – CIE - theory component and CIE – laboratory component. Students have to score a minimum of 40% Marks in the total of CIE - theory and CIE – laboratory components put together, provided students have to score a minimum of 40% marks in CIE laboratory component alone to qualify to take SEE.

Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration) and reduced to 50 Marks.

CONTINUOUS INTERNAL EVALUATION (CIE)		**Max Marks**		**Minimum Marks to be scored in CIE, to qualify to take SEE (40% individually)**
Theory	**Weightage of CIE1 and CIE2 Tests or CIE3**	**30**		**12**
Laboratory components	**Lab components:** Rubrics for each lab component are added, then taken average	**10**		
	Lab CIE	**10**	**20**	**08**
	TOTAL	**50**		**20**

CIE PATTERN		
Sl. No.	**Particulars**	**Max Marks**
Q 1	Any one question from Part -A	15
Q 2	Any one question from Part -B	25
Q 3	Viva Voice	10
		50 (Scale down to 10)

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2022-23 **CADEMIC YEAR: 2023-24**
SEMESTER: FOURTH

Course Title	**MANUFACTURING PROCESSES LABORATORY**	
Sub Code: 22MEL404	**No of Credits : 01** **0:0:1:0 (L-T-P)**	**No. of Practical hours/week :02**
Exam Duration: 3 hrs.	**CIE+SEE=50+50=100**	**Total No of contact hours: 26**
Category	**PCCL**	
Pre-requisites	**EME, Manufacturing Processes II**	

COURSE OBJECTIVES:

1. To use tools and produce simple models incorporating all the operations on a turning machine
2. To understand indexing and cut gear teeth using a horizontal milling machine

#	CONTENTS	Hrs.
PART A	**LATHE** Identify different turning tools, their parts, material and their use. Preparation of four models using a turning machine (lathe) involving following operations: • Facing - preliminary operation • Plain turning - preliminary operation • Step turning • Taper turning • Knurling • Thread cutting • Drilling • Boring • Internal-Thread-cutting • Eccentric-turning	**16**
PART B	**MILLING MACHINE** Identify milling tools, their parts, material and their use. Cutting of gear teeth on a given gear blank using milling machine after proper calculation on gear – 01 model	**10**

REFERENCE BOOKS:

1. Production Technology, R.K.Jain, Khanna Publications, 2003.
2. Production Technology, HMT, Tata McGraw Hill, 2001.
3. Manufacturing Technology - Vol. 2, P N Rao,TMH; Third edition (1 May 2013)
4. Production Technology, R.K.Jain, Khanna Publications, 2003.
5. Production Technology, P.C. Sharma, S Chand (1 December 2006)

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Get conversant with the lathe and prepare models.

CO2: Calculate the number of gear teeth that can be cut on the given blank using a milling machine.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	1	1	2	2	2	3	3	3	2	2
CO2	3	3	1	1	2	2	2	3	3	3	2	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

CONTINUOUS INTERNAL EVALUATION (CIE)

1. CIE has a maximum of 50 marks.
2. CIE Marks is finalized by conducting a test at the end of 12th week of the semester.
3. CIE Marks (50) = Evaluation of Record (30) + Test (20)

CONTINUOUS INTERNAL EVALUATION (CIE)	
LABORATORY RECORD WRITING	
PART-A	
Lathe tools, operations and model	20 MARKS
PART-B	
Tools, Operations and model on a milling machine	10 MARKS
TOTAL 1	**30 MARKS**
LABORATORY INTERNALS at the end of 12th week of the semester	
ONE lathe Model from PART A	30 MARKS
ONE model from PART B	10 MARKS
Viva – Voce	10 MARKS
	50 MARKS
TOTAL 2	**20 MARKS**
GRAND TOTAL (TOTAL 1 + TOTAL 2)	**50 MARKS**

SCHEME OF SEMESTER END EXAMINATION (SEE)	**MAXIMUM MARKS**
One model from **PART A**	30
One model from **PART B**	10
Viva – Voce	10
TOTAL	**50**

Dr Ambedkar Institute of Technology, Bengaluru-56
Department of Mechanical Engineering

ADMISSION YEAR : 2022-23 **ACADEMIC YEAR: 2023-24**
SEMESTER : FOURTH

Course Title	**NON TRADITIONAL MACHINING**	
Sub Code: 22MET405A	**No. of Credits: 3 = 3:0:0 (L-T-P)**	**No. of Lecture Hours/Week:03**
Exam Duration: 03 Hrs.	**Max. Marks : CIE+ Asmt +GA + SEE=40+5+5+50=100**	**Total No. of Contact Hours:40**
Category	**ESC**	
Pre-requisites	**Manufacturing processes**	

Course Learning Objectives:	
1	Understand the Mechanics of deformable bodies and apply them in analysis and design.
2	Evaluate the slope and deflection in beams subjected to different loading conditions.
3	Analyze a body subjected to two dimensional and three dimensional stress systems.
4	Interpret the torsional behavior of structural members. Assess the stability of columns and struts.
5	Examine the stresses in thin and thick cylinders subjected to loads.

UNIT No.	**Syllabus**	**No. of hours**	**BTLs**
1	**INTRODUCTION TO NON TRADITIONAL MACHINING**	**08**	**L1-L4**
	Introduction to Non-traditional machining, Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Non-traditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes.		
2	**ULTRASONIC (USM) & ABRASIVE JET MACHINING (AJM)**	**08**	**L1-L4**
	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. **Abrasive Jet Machining** Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD). Process characteristics-Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM.		**L1-L4**
3	**ELECTROCHEMICAL (ECM) & CHEMICAL MACHINING (CHM)**	**08**	**L1-L4**

	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. ECM Tooling: ECM tooling technique & example, Tool & insulation materials. Applications ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECG, ECH. **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.		
4	**LECTRICAL DISCHARGE (**EDM) & **PLASMA ARC MACHINING (PAM)**	**08**	**L1-L4**
	Electrical discharge machining (EDM): Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (relaxation type), dielectric medium-its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM, Electrical discharge grinding, Traveling wire EDM. P**lasma 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.		
5	**LASER BEAM** (LBM) & **ELECTRON BEAM MACHINING** (**EBM)**		
	Laser beam machining (LBM): Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations. **Electron beam machining (EBM):** Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations.		

TEXTBOOK/S

1 Modern Machining Process by P.C Pandey and H S Shah McGraw Hill Education India Pvt. Ltd. 2000

2 Production technology HMT McGraw Hill Education India Pvt. Ltd 2001

Course Outcomes: At the end of the course, the student will be able to	
1	Understand the compare traditional and non-traditional machining process and recognize the need for Non- traditional machining process.
2	Understand the constructional features, performance parameters, process characteristics, applications, advantages and limitations of USM, AJM and WJM.

3	: Identify the need of Chemical and electro-chemical machining process along with the constructional features, process parameters, process characteristics, applications, advantages and limitations.
4	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.
5	

Course Outcomes Mapping with Programme Outcomes & Programme Specific Outcomes.

Course Out Comes	**Level of CO**	**Program Outcomes**												**Programme specific outcomes**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1		3	3	3	3	2	0	0	0	0	0	2	0	3	0	0
CO2		3	3	3	3	2	0	0	0	0	0	2	0	3	0	0
CO3		3	3	3	3	2	0	0	0	0	0	2	0	3	0	0
CO4		3	3	3	3	2	0	0	0	0	0	2	0	3	0	0
CO5		3	3	3	3	2	0	0	0	0	0	2	0	3	0	0

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2022-23 **ACADEMIC YEAR: 2023-24**
SEMESTER : FOURTH

Course Title	**SUSTAINABLE ENGINEERING**	
Sub Code: 22MET406A	**No. of Credits: 1 = 1:0:0 (L-T-P)**	**No. of Lecture Hours/Week:01**
Exam Duration: 02 Hrs.	**Max. Marks : CIE+SEE=50+50=100**	**Total No. of Contact Hours:13**
Category	**AEC**	
Pre-requisites		

UNIT No.	SYLLABUS	No. of hours	BTLs
1	**SUSTAINABILITY**	**03**	**L1-L2**
	Introduction, concept, evolution of the concept; Social, environmental and economic sustainability concepts; Sustainable development, Nexus between Technology and Sustainable development; Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs), Clean Development Mechanism (CDM).		
2	**ENVIRONMENTAL POLLUTION**	**03**	**L1-L2**
	Air Pollution and its effects, Water pollution and its sources, Zero waste concept and 3 R concepts in solid waste management; Greenhouse effect, Global warming, Climate change, Ozone layer depletion, Carbon credits, carbon trading and carbon foot print, legal provisions for environmental protection.		
3	**ENVIRONMENTAL MANAGEMENT STANDARDS**	**03**	**L1-L2**
	ISO 14001:2015 frame work and benefits, Scope and goal of Life Cycle Analysis (LCA), Circular economy, Bio-mimicking, Environment Impact Assessment (EIA), Industrial ecology and industrial symbiosis.		
4	**RESOURCES AND ITS UTILISATION**	**02**	**L1-L2**
	Basic concepts of Conventional and non-conventional energy, General idea about solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans and Geothermal energy.		
5	**SUSTAINABILITY PRACTICES**	**02**	**L1-L2**
	Basic concept of sustainable habitat, Methods for increasing energy efficiency in buildings, Green Engineering, Sustainable Urbanisation, Sustainable cities, Sustainable transport.		

REFERENCE BOOKS

1. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
2. Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design

and development,Cengage learning

3. Environment Impact Assessment Guidelines, Notification of Government of India, 2006
4. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998
5. ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI Publications - GRIHA Rating System
6. Ni bin Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, McGraw-HillProfessional.
7. Twidell, J. W. and Weir, A. D., Renewable Energy Resources, English Language Book Society (ELBS).
8. Purohit, S. S., Green Technology - An approach for sustainable environment, Agrobios Publication

COURSE OUTCOMES: After the completion of the course the student will be able to

CO1: Understand the relevance and the concept of sustainability and the global initiatives in this direction
CO2: Explain the different types of environmental pollution problems and their sustainablesolutions
CO3: Discuss the environmental regulations and standards
CO4: Outline the concepts related to conventional and non-conventional energy
CO5: Demonstrate the broad perspective of sustainable practices by utilizing engineering knowledge and principles

Course Outcomes Mapping with Programme Outcomes & Programme Specific Outcomes.

Course Out Comes	Level of CO	Program Outcomes												Programme specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1							2	3					2	3	0	0
CO2							2	3					2	3	0	0
CO3							2	3					2	3	0	0
CO4							2	3					2	3	0	0
CO5							2	3					2	3	0	0

SCHEME FOR EXAMINATIONS

Pattern of question paper is MCQ (1 mark each).

CIE paper will be 25 objective type questions each of 1 mark

SEE paper will be 50 objective type questions each of 1 mark.

ADMISSION YEAR : 2022-23 **ACADEMIC YEAR: 2023-24**
SEMESTER : FOURTH

Course Title	**DESIGN AND ENGINEERING**	
Sub Code: 22MET406B	**No. of Credits: 1= 1:0:0 (L-T-P)**	**No. of Lecture Hours/Week:01**
Exam Duration: 02 Hrs.	**Max. Marks : CIE+SEE=50+50=100**	**Total No. of Contact Hours:13**
Category	**AEC**	
Pre-requisites		

COURSE LEARNING OBJECTIVES:

1. Introduce the undergraduate engineering students the fundamental principles ofdesign engineering,

2. To make them understand the steps involved in the design process and

3. To familiarize them with the basic tools used and approaches in design.

UNIT No.	Syllabus	No. of hours	BTLs
1	**DESIGN PROCESS**	**03**	**L1-L2**
	Introduction to Design and Engineering Design, Defining a Design Process- Detailing Customer Requirements, Setting Design Objectives, Identifying Constraints, Establishing Functions, Generating Design Alternatives and Choosing a Design.		
2	**DESIGN THINKING APPROACH:-**	**03**	**L1-L2**
	Introduction to Design Thinking, Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. Design Thinking as Divergent-Convergent Questioning. Design Thinking in a Team Environment.		
3	**DESIGN COMMUNICATION (LANGUAGES OF ENGINEERING DESIGN)**	**03**	**L1-L2**
	Communicating Designs Graphically, Communicating Designs Orally and in Writing. Mathematical Modeling In Design, Prototyping and Proofing the Design.		
4	**DESIGN ENGINEERING CONCEPTS:-**	**02**	**L1-L2**
	Project-based Learning and Problem-based Learning in Design, .Modular Design and Life Cycle Design Approaches. Application of Bio- mimicry, Aesthetics and Ergonomics in Design. Value Engineering, Concurrent Engineering, and Reverse Engineering in Design.		
5	**EXPEDIENCY, ECONOMICS AND ENVIRONMENT IN DESIGN**	**02**	**L1-L2**

	ENGINEERING:-		
	Design for Production, Use, and Sustainability. Engineering Economics in Design. Design Rights. Ethics in Design		

TEXT BOOKS

1) YousefHaik, SangarappillaiSivaloganathan, Tamer M. Shahin, Engineering Design Process,Cengage Learning 2003, Third Edition, ISBN-10: 9781305253285.

2) Voland, G., Engineering by Design, Pearson India 2014, Second Edition, ISBN 9332535051

REFERENCE BOOKS

1. Philip Kosky, Robert Balmer, William Keat, George Wise, Exploring Engineering, Fourth Edition: An Introduction to Engineering and Design, Academic Press 2015, 4th Edition,ISBN: 9780128012420.
2. Clive L. Dym, Engineering Design: A Project-Based Introduction, John Wiley & Sons,New York 2009, Fourth Edition, ISBN: 978-1-118-32458-5
3. Nigel Cross, Design Thinking: Understanding How Designers Think and Work, BergPublishers 2011, First Edition, ISBN: 978-1847886361
4. Pahl, G., Beitz, W., Feldhusen, J., Grote, K.-H., Engineering Design: A SystematicApproach, Springer 2007, Third Edition, ISBN 978-1-84628-319-2.

Course Outcomes: After the completion of the course the student will be able to

CO1: Explain the different concepts and principles involved in design engineering.

CO2: Apply design thinking while learning and practicing engineering.

CO3: Develop innovative, reliable, sustainable and economically viable designs incorporating knowledge in engineering.

Course Outcomes Mapping with Programme Outcomes & Programme Specific Outcomes.

Course Out Comes	Level of CO	Program Outcomes												Programme specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		2	1					1			1			3	0	0
CO2			2				1		1				2	3	0	0
CO3				2			1	1		2	2		1	3	0	0

SCHEME FOR EXAMINATIONS

Pattern of question paper is MCQ (1 mark each).

CIE paper will be 25 objective type questions each of 1 mark

SEE paper will be 50 objective type questions each of 1 mark.

Dr. Ambedkar Institute of Technology, Bengaluru-560056
Outcome Based Education(OBE) and Choice Based Credit System
B.E. Mechanical Engineering
Tentative Scheme of Teaching and Examination effective from the Academic Year 2023-24

III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Department (TD) and Question Paper Setting	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PCC	22MET301	Mechanics of Materials	Mechanical	3	0	0		03	50	50	100	3
2	IPCC	22MEU302	Material Science and Metallurgy	Mechanical	3	0	2		03	50	50	100	4
3	IPCC	22 MEU303	Manufacturing Processes	Mechanical	3	0	2		03	50	50	100	4
4	PCC	22MET304	Basic Thermodynamics	Mechanical	3	0	0		03	50	50	100	3
5	PCCL	22MEL305	Computer Aided Machine Drawing	Mechanical	0	0	2		03	50	50	100	1
6	ESC	22MET306x	ESC/ETC/PLC	Mechanical	3	0	0		03	50	50	100	3
7	UHV	22HST307	Social Connect and Responsibility	Any Department	0	0	2		01	100	---	100	1
8	AEC/ SEC	22MET308x or 22MEL308x	Ability Enhancement Course/Skill Enhancement Course – III	Mechanical	If the course is a Theory: 1	0	0		01	50	50	100	1
					If a course is a laboratory: 0	0	2		02				
9	HS	22CDN309	Aptitude and Verbal Ability Skill-I	Placement Cell	2	0	0		--	50	--	50	PP/NP
10	MC	22NSN310	National Service Scheme (NSS)	NSS coordinator	0	0	2		--	100	---	100	PP/NP
		22PEN310	Physical Education (PE) (Sports and Athletics)	Physical Education Director									
		22YON310	Yoga	Yoga Teacher									
									Total	**550**	**350**	**900**	**20**

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **MC**: Mandatory Course (Non-credit), **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical, S= Self-Study, **CIE**: Continuous Internal Evaluation, **SEE**:Semester End Evaluation. K: This letter in the course code indicates common to all the streams of Engineering. ESC: Engineering Science Course, ETC: Emerging Technology Course, PLC: Programming Language Course

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Engineering Science Course (ESC/ETC/PLC) 22XXT306x			
22MET306A	Electric and Hybrid Vehicle Technology		
Ability Enhancement Course – III 22XXT308x **OR** 2XXL308x			
22MET308A	INDUSTRY 4.0		

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical of the same course. Credit for IPCC can be 04 and its Teaching– Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education(PE) (Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first Week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the Degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of Degree.

Dr.Ambedkar Institute of Technology, Bengaluru-560056
Outcome Based Education(OBE) and Choice Based Credit System
B.E. Mechanical Engineering
Tentative Scheme of Teaching and Examination effective from the Academic Year 2023-24

IV SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory	Tutorial	Practical/ Drawing	Self - Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PCC	22MET401	Theory of Machines	Mechanical	3	0	0		03	50	50	100	3
2	IPCC	22MEU402	Mechanical Measurements	Mechanical	3	0	2		03	50	50	100	4
3	IPCC	22MEU403	Applied Thermodynamics	Mechanical	3	0	2		03	50	50	100	4
4	PCCL	22MEL404	Manufacturing Processes Laboratory	Mechanical	0	0	2		03	50	50	100	1
5	ESC	22MET405x	ESC/ETC/PLC	Mechanical	3	0	0		03	50	50	100	3
6	AEC/ SEC	22MET406x or 22MEL406x	Ability Enhancement Course/Skill Enhancement Course- IV	TD and PSB: Concerned department	If the course is Theory				01	50	50	100	1
					1	0	0						
					If the course is a lab				02				
					0	0	2						
7	BSC	22BIT407	Biology For Engineers	TD / PSB: BT, CHE,	3	0	0		03	50	50	100	3
8	UHV	22HST408	Universal human values course	Any Department	1	0	0		01	50	50	100	1
9	HS	22CDN409	Aptitude and Verbal Ability Skill-II	Placement Cell	2	0	0		--	50	--	50	PP/ NP
10	MC	22NSN410	National Service Scheme (NSS)	NSS coordinator	0	0	2			100	---	100	PP/ NP
		22PEN410	Physical Education (PE) (Sports and Athletics)	Physical Education Director									
		22YON410	Yoga	Yoga Teacher									
									Total	**500**	**400**	**900**	**20**

PCC: Professional Core Course, PCCL: Professional Core Course laboratory, UHV: Universal Human Value Course, MC: Mandatory Course (Non-credit), AEC: Ability Enhancement Course, SEC: Skill Enhancement Course, L: Lecture, T: Tutorial, P: Practical, S= Self-Study, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation. K : This letter in the course code indicates common to all the stream of engineering.

Engineering Science Course (ESC/ETC/PLC) 22XXT405x OR 22XXL405x			
22MET405A	Non Traditional Machining		
Ability Enhancement Course / Skill Enhancement Course – IV 22XXT405x OR 22XXL406x			
22MET406A	Sustainable Engineering		
22MET406B	Design and Engineering		

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National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education(PE)(Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first Week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the Degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses is mandatory for the award of Degree.