

**Puducherry Technological University**  
**Puducherry –605014**  
(A Technological University of Government of Puducherry)



**Curriculum and Syllabi**  
**for**  
**B. Tech. (Mechanical Engineering)**  
(Effective from Academic year 2024-25)

**(Subject to the Approval of the Fifth Academic Council meeting of  
Puducherry Technological University)**

# **Department of Mechanical Engineering Puducherry Technological University**

## **VISION OF THE DEPARTMENT**

To produce dynamic, vibrant, demand driven and quality conscious human resource through consistent and sustained development ensuring highest standards of technological ethics.

## **MISSION OF THE DEPARTMENT**

- Strengthening the department to produce high quality engineers
- Scaling up education, research and development
- Evincing expertise through centers of excellence in focused areas of mechanical engineering

## CURRICULUM AND SYLLABUS

The Curriculum of B.Tech. (Mechanical Engineering) is designed to fulfil the Program Educational Objectives (PEO) and the Program Outcomes (PO) listed below.

### **PROGRAM EDUCATIONAL OBJECTIVES (PEO)**

<b>PEO1</b>	Our graduates will design, evaluate, and improve techno-economically feasible and sustainable mechanical and manufacturing systems.
<b>PEO2</b>	Our graduates will adapt to the dynamic and evolving technologies with a coherent and flexible decision making approach, promoting sustainable solution to address broader society challenges.
<b>PEO3</b>	Our graduates will inculcate and imbibe with modern techniques viz., design thinking, offline/online industrial tools simultaneously taking cognizance of societal, environmental and professional ethical aspects.
<b>PEO4</b>	Our graduates will play a key role in the Nation's progress by leveraging their skills to address a wide array of complex industrial challenges in design and manufacturing.

### **PROGRAM OUTCOMES (PO)**

<b>PO1</b>	<b>Engineering Knowledge:</b> Apply the knowledge of Mathematics, Natural science, Computing, Engineering Fundamentals and an Engineering Specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems
<b>PO2</b>	<b>Problem Analysis:</b> Identify, formulate review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1-WK4)
<b>PO3</b>	<b>Design / Development of solutions:</b> design creative solutions for complex engineering problems and design / develop systems / components / processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5).
<b>PO4</b>	<b>Conduct Investigations of complex problems:</b> Conduct investigations of complex engineering problems using research based knowledge including design of experiments, modelling, analysis and interpretation of data to provide valid conclusions. (WK8).
<b>PO5</b>	<b>Engineering Tool Usage:</b> Create, select and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 & WK6).
<b>PO6</b>	<b>The Engineer and the world:</b> Analyse and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5 and WK7).
<b>PO7</b>	<b>Ethics:</b> Apply ethical principles and commit to professional ethics, human values.

	Diversity and inclusion, adhere to national and international laws. (WK9).
<b>PO8</b>	<b>Individual and Collaborative Team Work:</b> Function effectively as an individual, and as a member or leader in diverse / multi-disciplinary teams.
<b>PO9</b>	<b>Communication:</b> Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentations, make effective presentations considering cultural, language, and learning differences
<b>PO10</b>	<b>Project Management and Finance:</b> Apply knowledge and understanding of engineering management principles and economic decision making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
<b>PO11</b>	<b>Life-long learning:</b> Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8).

### KNOWLEDGE AND ATTITUDE PROFILE (WK)

<b>WK1</b>	A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences
<b>WK2</b>	Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
<b>WK3</b>	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
<b>WK4</b>	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
<b>WK5</b>	Knowledge, including efficient resource use, environmental impacts, whole-life cost, reuse of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
<b>WK6</b>	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline
<b>WK7</b>	Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
<b>WK8</b>	Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
<b>WK9</b>	Ethics, inclusive behaviour and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

### **PROGRAM SPECIFIC OUTCOMES (PSO)**

<b>PSO1</b>	Students learn appropriate skills to model, design and manufacture products or systems and orient themselves towards research, employment and innovation.
<b>PSO2</b>	Students acquire knowledge and proficiency in the area of sustainable development and manufacturing.

### **Distribution of credits among the subjects grouped under various categories:**

Courses are grouped under various categories and the credits to be earned in each category of courses are as follows:

<b>Sl. No.</b>	<b>Category</b>	<b>Credits</b>	<b>Course Category Code (CCC)</b>
1	Basic Science Courses	20	BSC
2	Engineering Science Courses	6	ESC
3	Professional Core Courses	93	PCC
4	Professional Elective Courses	12	PEC
5	Ancillary Stream Courses	12	ANC
6	Ability Enhancement Courses	10	AEC
7	Skill Enhancement Courses	6	SEC
8	Value Added Courses	4	VAC
	<b>Total</b>	<b>163</b>	

## Semester-wise Courses and Credits

### Semester I

Course Code	Course	CCC	Periods			Credits
			L	T	P	
	3 weeks compulsory Induction Program					
MAUC101	Mathematics I	BSC	3	1	-	4
MEUC102	Engineering Mechanics	PCC	3	1	-	4
PHUC101	Physics	BSC	3	-	-	3
MEUC101	Engineering Graphics	ESC	1	-	4	3
HSUA101	English for Communication	AEC	2	-	-	2
GEUS101	Basic Engineering Skills Laboratory - I	SEC	1	-	4	3
GEUV101	NSS, Yoga and Health	VAC	-	-	2	1
PHUC102	Physics Laboratory	BSC	-	-	2	1
<b>Total</b>			13	2	12	-
			27			21

CCC - Course Category Code, L-Lecture, T – Tutorial, P – Practical

### Semester II

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MAUC102	Mathematics II	BSC	3	1	-	4
MEUC103	Engineering Thermodynamics	PCC	3	1	-	4
CYUC101	Chemistry	BSC	3	-	-	3
CSUC101	Programming for Problem Solving	ESC	2	-	-	2
HSUA102	Professional English	AEC	2	-	-	2
GEUS102	Basic Engineering Skills Laboratory - II	SEC	1	-	4	3
GEUV102	Essence of Indian Traditional Knowledge	VAC	1	-	-	1
CYUC102	Chemistry Laboratory	BSC	-	-	2	1
CSUC102	Computer Programming Laboratory	ESC	-	-	2	1
<b>Total</b>			15	2	8	
			25			21

**Exit Option** for the students who opt to exit after completion of first year of B. Tech Programme and have secured a **minimum of 42 credits** will be awarded a UG certificate in a discipline if, in addition they complete **one vocational course of 4 credits** during the summer vacation of the first year

### Semester III

Course Code	Course	CCC	Periods			Credits
			L	T	P	
<b>MAUC104</b>	<b><i>Transforms and Partial Differential Equations</i></b>	BSC	3	1	-	<b>4</b>
MEUC104	Fluid Mechanics and Hydraulic Machines	PCC	3	1	-	<b>4</b>
MEUC105	Mechanics of Solids	PCC	3	1	-	<b>4</b>
MEUC106	Materials Technology	PCC	3	-	-	<b>3</b>
MEUC107	Machine Drawing and Drafting	PCC	2	-	2	<b>3</b>
<b>HSUA103</b>	<b><i>Entrepreneurship</i></b>	AEC	2	-	-	<b>2</b>
<b>GEUV103</b>	<b><i>Environmental Education</i></b>	VAC	1	-	-	<b>1</b>
MEUC108	Fluid Mechanics and Hydraulic Machines Laboratory	PCC	-	-	2	<b>1</b>
MEUC109	Material Testing and Metallurgy Laboratory	PCC	-	-	2	<b>1</b>
<b>Total</b>			17	3	6	<b>-</b>
			26			<b>23</b>

### Semester IV

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MEUC110	Renewable Energy Sources	PCC	3	-	-	<b>3</b>
MEUC111	Thermal Engineering- I	PCC	3	1	-	<b>4</b>
MEUC112	Kinematics of Machines	PCC	3	1	-	<b>4</b>
MEUC113	Manufacturing Processes	PCC	3	-	-	<b>3</b>
<b>HSUA104/ HSUA106</b>	<b><i>Design Thinking / Language –French</i></b>	AEC	2	-	-	<b>2</b>
<b>GEUV104</b>	<b><i>Universal Human Values</i></b>	VAC	1	-	-	<b>1</b>
MEUC114	Dynamics of Machines Laboratory	PCC	-	-	2	<b>1</b>
MEUC115	Manufacturing Processes Laboratory	PCC	-	-	2	<b>1</b>
<b>Total</b>			15	2	4	<b>-</b>
			21			<b>19</b>

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MEUNXXX	Ancillary Stream Course –I	ANC	3	-	-	<b>3</b>
MEUH101	Hydrogen Energy and Fuel Cell (Honours Course – I)	PCC	3	1	-	<b>4</b>

**Exit option** for the students who opt to exit after completion of II year of B. Tech Programme and have secured a **minimum of 87 credits will be awarded UG Diploma in a discipline, if in addition they complete one vocational course in summer vacation of the second year**

### Semester V

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MEUC116	Heat and Mass Transfer	PCC	3	1	-	4
MEUC117	Dynamics of Machines	PCC	3	1	-	4
MEUC118	Metrology and Measurements	PCC	4	-	-	4
MEUC119	Machining Processes	PCC	3	-	-	3
MEUEXXX	Professional Elective – I	PEC	3	1	-	4
MEUC120	Heat Transfer Laboratory	PCC	-	-	2	1
MEUC121	Machining Processes Laboratory	PCC	-	-	2	1
<b>Total</b>			16	3	4	-
			23			21

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MEUNXXX	Ancillary Stream Course –II	ANC	3	-	-	3
MEUH102	Failure Analysis and Prevention (Honours Course – II)	PCC	3	1	-	4

### Semester VI

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MEUC122	Thermal Engineering-II	PCC	3	1	-	4
MEUC123	Design of Machine Elements	PCC	3	1	-	4
<b>HSUA105</b>	<b><i>Industrial Economics and Management</i></b>	AEC	2	-	-	2
MEUEXXX	Professional Elective – II	PEC	3	1	-	4
MEUC124	Thermal Engineering Laboratory	PCC	-	-	2	1
MEUC125	Metrology and Measurements Laboratory	PCC	-	-	2	1
MEUC126	Internship	PCC	-	-	-	2
<b>Total</b>			11	3	4	-
			18			18

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MEUNXXX	Ancillary Stream Course –III	ANC	3	-	-	3
MEUH103	Reliability Engineering (Honours Course – III)	PCC	3	1	-	4

**Exit option** for the students who opt to exit after completion of third year of B. Tech Programme and have secured a **minimum of 132 credits** will be awarded **B.Sc. (Engg.) in a discipline, if in addition they complete one vocational course in summer vacation of the second year**

### Semester VII

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MEUC127	Automobile Engineering	PCC	4	-	-	4
MEUC128	Computer Integrated Manufacturing	PCC	4	-	-	4
MEUC129	Industrial Engineering, Maintenance and Safety	PCC	4	-	-	4
MEUEXXX	Professional Elective – III	PEC	3	1	-	4
MEUC130	Modelling and Simulation Analysis Laboratory	PCC	-	-	2	1
MEUC131	Mini Project	PCC	-	-	4	2
MEUC132	Comprehensive Viva	PCC	-	-	2	1
<b>Total</b>			15	1	8	-
			24			20

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MEUNXXX	Ancillary Stream Course –IV	ANC	3	-	-	3
MEUH104	Engineering Optimization (Honours Course – IV)	PCC	3	1	-	4

### Semester VIII

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MEUC133	Project work	PCC	-	-	16	8

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MEUH105	Seminar (Honours Course – V)	PCC	-	-	4	2

## LIST OF PROFESSIONAL ELECTIVES

Professional Elective	Course Code	Course	Semester
Professional Elective - I	MEUE101	Product Engineering and Design Thinking	V
	MEUE102	Power Plant Engineering	
	MEUE103	Operations Research	
	MEUE104	Computer Aided Design	
Professional Elective – II	MEUE105	Solar Energy Engineering	VI
	MEUE106	Statistical Quality Control	
	MEUE107	Industrial Robotics	
	MEUE108	Fluid Power Automation	
	MEUE109	Finite Element Method	
Professional Elective - III	MEUE110	Computational Fluid Dynamics	VII
	MEUE111	Total Quality Management	
	MEUE112	Design of Transmission Systems	
	MEUE113	Electric and Hybrid Automotive vehicle Technology	

## LIST OF ANCILLARY COURSES

Ancillary Stream Title	Course Code	Course	Semester
Alternate Energy Sources (For all branches except Mechanical)	MEUN101	Solar Energy	IV, V, VI, VII
	MEUN102	Wind, Wave and Tidal Energy	
	MEUN103	Bio-Energy	
	MEUN104	Hydrogen, OTEC and Geothermal Energy	
Industrial Automation (For all branches except Mechanical)	MEUN105	AI in Mechanical Engineering	
	MEUN106	Robotics and Automation	
	MEUN107	Sensors and Actuators	
	MEUN108	Smart Manufacturing	
Industry 4.0 (only for Mechanical students)	MEUI101	AI in Manufacturing Engineering	
	MEUI102	ML Applications in Mechanical Engineering	
	MEUI103	Fault Diagnosis and Signal Processing	
	MEUI104	Additive Manufacturing	

## Courses offered under various categories

CCC	Course Code	Course	Semester	Credit	Total Credits
<b>BSC</b>	MAUC101	Mathematics – I	I	4	<b>20</b>
	PHUC101	Physics	I	3	
	CYUC101	Chemistry	II	3	
	PHUC102	Physics laboratory	I	1	
	CYUC102	Chemistry Laboratory	II	1	
	MAUC102	Mathematics –II	II	4	
	MAUC104	Transforms and Partial Differential Equations	III	4	
<b>ESC</b>	MEUC101	Engineering Graphics	I	3	<b>6</b>
	CSUC101	Programming for Problem Solving	II	2	
	CSUC102	Computer Programming Laboratory	II	1	
<b>PCC</b>	MEUC102	Engineering Mechanics	I	4	<b>93</b>
	MEUC103	Engineering Thermodynamics	II	4	
	MEUC104	Fluid Mechanics and Hydraulic Machines	III	4	
	MEUC105	Mechanics of Solids	III	4	
	MEUC106	Materials Technology	III	3	
	MEUC107	Machine Drawing and Drafting	III	3	
	MEUC108	Fluid Mechanics and Hydraulic Machines Laboratory	III	1	
	MEUC109	Material Testing and Metallurgy Laboratory	III	1	
	MEUC110	Renewable Energy Sources	IV	3	
	MEUC111	Thermal Engineering- I	IV	4	
	MEUC112	Kinematics of Machines	IV	4	
	MEUC113	Manufacturing Processes	IV	3	
	MEUC114	Dynamics of Machines Laboratory	IV	1	
	MEUC115	Manufacturing Processes Laboratory	IV	1	
	MEUC116	Heat and Mass Transfer	V	4	
	MEUC117	Dynamics of Machines	V	4	
	MEUC118	Metrology and Measurements	V	4	
	MEUC119	Machining Processes	V	3	
	MEUC120	Heat Transfer Laboratory	V	1	
	MEUC121	Machining Processes Laboratory	V	1	
	MEUC122	Thermal Engineering-II	VI	4	
	MEUC123	Design of Machine Elements	VI	4	
	MEUC124	Thermal Engineering Laboratory	VI	1	
	MEUC125	Metrology and Measurements Laboratory	VI	1	
	MEUC126	Internship	VI	2	
	MEUC127	Automobile Engineering	VII	4	
	MEUC128	Computer Integrated Manufacturing	VII	4	

	MEUC129	Industrial Engineering, Maintenance and Safety	VII	4	
	MEUC130	Modelling and Simulation Analysis Laboratory	VII	1	
	MEUC131	Mini Project	VII	2	
	MEUC132	Comprehensive Viva	VII	1	
	MEUC133	Project work	VIII	8	
<b>PEC</b>	MEUEXXX	Professional Elective – I	V	4	<b>12</b>
	MEUEXXX	Professional Elective – II	VI	4	
	MEUEXXX	Professional Elective – III	VII	4	
<b>AEC</b>	HSUA101	English for Communication	I	2	<b>10</b>
	HSUA102	Professional English	II	2	
	HSUA103	Entrepreneurship	III	2	
	<b>HSUA104/ HSUA106</b>	<b>Design Thinking / Language -French</b>	IV	2	
	HSUA105	Industrial Economics and Management	VI	2	
<b>SEC</b>	GEUS101	Basic Engineering Skills Laboratory - I	I	3	<b>6</b>
	GEUS102	Basic Engineering Skills Laboratory - II	II	3	
<b>VAC</b>	GEUV101	NSS, Yoga and Health	I	1	<b>4</b>
	GEUV102	Essence of Indian Traditional Knowledge	II	1	
	GEUV103	Environmental Education	III	1	
	GEUV104	Universal Human Values	IV	1	
<b>ANC</b>	MEUN 101-108	Ancillary Stream Elective course	<b>IV-VII</b>	12	<b>12</b>
<b>Total</b>					<b>163</b>

# **SEMESTER – III**

Department : Mathematics			Programme : B.Tech (ME)					
Semester : Third			Course Category Code: BSC			Exam Type: TY		
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
MAUC104	Transforms and Partial Differential Equations	3	1	-	4	40	60	100
Prerequisite:	Basic Integration and Probability							
Course Outcomes At the end of the course the student will be able to	CO1	Explain the concept of Laplace Transform and its inverse.						
	CO2	Utilize Laplace Transform to solve the odes.						
	CO3	Analyze various methods of solving first order PDE.						
	CO4	Determine the solution of higher order PDE and applying the method of variable separation to solve wave equation.						
	CO5	Make use of Fourier series method to solve heat equations.						
UNIT-I	Laplace Transforms						Periods : 12	
Definition of Laplace Transform, Inverse Laplace Transform, Linearity property, Laplace transform of unit step function, Unit impulse function and some elementary functions, Change of scale and first shifting property, Laplace transform of Periodic functions						CO1		
UNIT-II	Applications of Laplace Transforms						Periods : 12	
Derivatives and integrals of Laplace transform, Transform of derivatives and integrals, Application: Solution of single ordinary linear differential equation with constant coefficients, Initial and Final value theorem.						CO1, CO2		
UNIT-III	Partial Differential Equations						Periods : 12	
General and Singular solution of PDE, Complete Solution of First order linear and Non-linear PDE First order linear PDE - method of grouping and Lagrange's multipliers method.						CO3		
UNIT-IV	Higher Order PDE and Boundary Value Problems						Periods : 12	
Homogeneous linear PDE of higher order with constant coefficients. Solution of partial differential equation by the method of separation of variables. Application of PDE: Variable separable solutions of the one dimensional wave equation, Transverse vibration of a stretched string.						CO3, CO4		
UNIT-V	1-D and 2-D Heat Flow Equation						Periods : 12	
Heat Equation, Solution of one dimensional heat equation by the method of separation of variables, Temperature distribution with zero and non-zero boundary values, Two dimensional heat flow under steady state conditions(Cartesian).						CO3, CO4, CO5		
Lecture Periods: 45		Tutorial Periods: 15		Practical Periods: -		Total Periods: 60		
Reference Books:								
1. Veerarajan T, Engineering Mathematics I & II, McGraw-Hill Education(India) Private Limited, 2019								
2. Veerarajan T, Transforms and Partial Differential Equations, Third Edition, McGraw-Hill Education(India) Private Limited, 2016.								
3. Venkataraman M.K., Engineering Mathematics, Third Year, Part-B, The National Publishing Company, Chennai, 2008.								
4. Erwin Kreyszig, Advanced Engineering Mathematics (9 th Ed), John Wiley & Sons, New Delhi, 2011.								
5. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, Eleventh								

Reprint, 2010.

6. Bali N. and Goyal M., Advanced Engineering Mathematics, Laxmi Publications Pvt. Ltd., New Delhi, 9<sup>th</sup> Edition, 2011.

7. B.S. Grewal "Higher Engineering Mathematics" (44<sup>th</sup> Ed), Khanna Publishers, 2018.

### **CO – PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	2	3	1	-	1	2	1	2	1	-
CO2	3	3	2	3	3	1	-	1	2	1	2	1	-
CO3	3	3	2	3	3	2	-	1	2	1	2	1	-
CO4	3	3	2	3	3	2	-	1	2	1	2	1	-
CO5	3	3	2	3	3	2	-	1	2	1	2	3	-
Mean	3	2.8	1.8	2.8	3	1.6	-	1	2	1	2	1.4	-

Department : Mechanical Engineering		Programme : B.Tech (ME)						
Semester : Third		Course Category Code: PCC				Semester Exam Type: TY		
Course Code	Course Name	Periods/week			Credit	Maximum Marks		
MEUC104	Fluid Mechanics and Hydraulic Machines	L	T	P	C	CA	SE	TM
		3	1	-	4	40	60	100
Prerequisite	Basic physics, Engineering Thermodynamics and Mathematics							
Course Outcome At the end of the course students will be able to	CO1	identify the types of fluid flow system and apply conservation laws to fluid flow problems in engineering applications						
	CO2	understand the phenomenology of viscous and non-viscous flows and the analysis of fully developed flows.						
	CO3	evaluate the losses associated with fluid flows to calculate the pumping power requirements. Develop the governing equations by using methods of order of magnitude analysis.						
	CO4	analyze and determine the forces exerted by the fluid in static and in dynamics to understand the mechanism involved in converting the force to mechanical power.						
	CO5	design to understand the piping network and the performance characteristics of hydraulic machines used in power plants.						
UNIT-I	Fluid Statics					Periods: 12		
Fluid properties. Fluid statics: Pascal's law-hydrostatic law–scale of pressure measurement- Manometer: simple, inclined differential U-tube manometers. Hydrostatic forces on surfaces: Centre of pressure and total pressure. Buoyancy and floatation.							CO1, CO4	
UNIT-II	Fluid Kinematics					Periods: 12		
Types of fluid flow, continuity equation in rectangular and cylindrical coordinate systems-velocity and acceleration-stream lines, path lines, streak lines and flow net-Types of motion – rotation-velocity potential function and stream function.							CO1, CO2, CO3	
UNIT-III	Fluid Dynamics					Periods: 12		
Equations of motion- Euler's equation. Bernoulli's equation and its applications: Venturimeter, Orifice meter and Pitot tube. Flow through pipes: Hagen Poiseuille formula. Energy losses: major loss and minor losses - Darcy Formula-Compound pipe and equivalent pipe. Dimensional analysis- Application of Buckingham Pi theorem for problems in fluid mechanics. Introduction to Boundary layer flow: Flow over a flat plate (theoretical treatment only)							CO1, CO2, CO4	
UNIT-IV	Hydraulic Turbines					Periods: 12		
Impulse momentum equation- impact of jet: Force exerted by jet on stationary and moving plates/vanes –calculation of work and power. Hydraulic turbines: classification- Impulse Turbine-Pelton wheel- Reaction Turbine-Francis and Kaplan turbines-velocity triangles- calculation of power developed.							CO1, CO4, CO5	
UNIT-V	Hydraulic Pumps					Periods: 12		
Classification-Centrifugal pump- velocity triangles-calculation of power required- pump efficiency-priming. Performance of hydraulic machines: Unit quantities and specific speed, performance characteristics curves – Cavitation. Reciprocating pump-types-working principle-air vessels. Submersible, Mono-block & Gear pumps (theoretical treatment only).							CO1, CO4, CO5	

<b>Lecture Periods: 45</b>	<b>Tutorial Periods:15</b>	<b>Practical Periods: -</b>	<b>Total Periods: 60</b>
<b>Reference Books:</b>			
<ol style="list-style-type: none"> <li>Victor L Streeter, E. Benjamin Wylie and K.W. Bedford, Fluid Mechanics, 9<sup>th</sup> edition, McGraw–Hill, New Delhi, 2010</li> <li>Kumar K.L, Engineering Fluid Mechanics, 1<sup>st</sup> edition, S. Chand publishers, 2016.</li> <li>Bansal. R.K, A Text book of Fluid Mechanics and Hydraulics Machines, 10<sup>th</sup> edition, Laxmi publications (P) Ltd, New Delhi, 2018</li> <li>Frank M. White, Fluid Mechanics, 8th edition, Tata McGraw–Hill, New Delhi, 2016.</li> <li>Robert W Fox &amp; Alan T. McDonald, Fluid Mechanics, 8th edition, John Wiley, 2015</li> <li>Yunus Cengel &amp; John Cimbala, Fluid Mechanics: Fundamentals and Applications McGraw Hill Education (India) Private Limited, 2014.</li> <li>Munson, Young, Okiishi and Huebsch, Fundamental of fluid mechanics, Wiley India Private Limited, 2009.</li> <li>Som. S &amp; Gautham Biswas, Introduction to fluid mechanics and fluid machines, McGraw Hill Education (India) Private Limited, 2011.</li> </ol>			

### **CO-PO / PSO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	-	1	-	-	-	-	-	-	-	1	-
CO2	3	2	-	-	-	-	-	-	-	-	1	2	1
CO3	3	3	3	1	1	-	-	-	-	-	1	2	1
CO4	3	3	2	1	1	-	-	-	-	-	1	2	1
CO5	3	3	3	1	1	-	-	-	-	-	1	2	2
Mean	3	2.8	1.6	0.8	0.6	-	-	-	-	-	0.8	1.8	1

**3- High, 2-Medium, 1-Low**

<b>Department : Mechanical Engineering</b>		<b>Programme : B.Tech (ME)</b>						
<b>Semester : Third</b>		<b>Course Category Code: PCC</b>				<b>Semester Exam Type: TY</b>		
<b>Course Code</b>	<b>Course Name</b>	<b>Periods/week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
<b>MEUC105</b>	<b>Mechanics of Solids</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CA</b>	<b>SE</b>	<b>TM</b>
		<b>3</b>	<b>1</b>	<b>-</b>	<b>4</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>Prerequisite</b>	Engineering Mechanics							
<b>Course Outcome</b> At the end of the course students will be able to	<b>CO1</b>	analyze stresses, strains, and deformations in solid bodies under axial, transverse, and torsional loads, and evaluate the mechanical properties of materials to solve statically determinate and indeterminate problems.						
	<b>CO2</b>	develop shear force and bending moment diagrams for beams under transvers loading and determine the distribution of bending and shear stresses in beam using the flexure formula.						
	<b>CO3</b>	evaluate torsional deformation in circular shafts, analyze power transmission in shafts, and solve problems involving combined bending and torsion in statically indeterminate systems.						
	<b>CO4</b>	determine the deflection of beams using methods such as double integration, Macaulay’s, and area moment methods, and apply these techniques to solve problems involving beam deformation.						
	<b>CO5</b>	analyze stresses in thin and thick-walled cylinders and spheres, and compare the results using Lamé’s theory and thin cylinder theory to evaluate their applications in pressure vessel design.						
<b>UNIT-I</b>	<b>Stress, strain and deformation of solids</b>					<b>Periods: 12</b>		
Stress – Strain – Mechanical Properties of Materials – Axial load - Statically Indeterminate Structures – Plane Stress- Elastic Constants Principal Stresses and Maximum Shear Stresses							CO1	
<b>UNIT-II</b>	<b>Transverse loading on beams and stresses in beam</b>					<b>Periods: 12</b>		
Shear and Moment Diagrams – Cantilever, Simply Supported and Over Hanging Beams - The Flexure Formula – Bending Stress and Shear Stress Distribution							CO1, CO2	
<b>UNIT-III</b>	<b>Torsion</b>					<b>Periods: 12</b>		
Torsional Deformation of a Circular Shaft - Power Transmission - Statically Indeterminate Torque-Loaded Members – Combined Bending Moment and Torsion of Shafts – Shafts in Series and Parallel							CO1, CO3	
<b>UNIT-IV</b>	<b>Deflection of Beams</b>					<b>Periods: 12</b>		
Elastic Curve – Governing Differential Equation – Double Integration Method – Macaulay’s Method – Area Moment Method							CO1, CO4	
<b>UNIT-V</b>	<b>Thin Cylinders, spheres and Thick cylinders:</b>					<b>Periods: 12</b>		
Stresses in Thin Cylinder – Hoop and Longitudinal – Effects of End Plates – Thick Cylinders – Lamé’s Theory – Comparison with thin cylinder theory							CO1, CO2, CO5	
<b>Lecture Periods: 45</b>		<b>Tutorial Periods:15</b>		<b>Practical Periods: -</b>		<b>Total Periods: 60</b>		
<b>Reference Books:</b>								
1. Rattan S.S., Strength of Materials, Tata McGraw Hill Education Pvt.Ltd., New Delhi, 2017.								
2. Hibbeler R.C., Mechanics of Materials, 9 <sup>th</sup> Edition, Prentice Hall, New Delhi, 2014								
3. Rajput R.K. Strength of Materials (Mechanics of Solids), S.Chand & company Ltd., New Delhi, 7th edition, 2018.								
4. Beer. F.P. & Johnston. E.R. Mechanics of Materials, Tata McGraw Hill, 8th Edition, New Delhi								

2019.

5. Singh. D.K., Strength of Materials, Ane Books Pvt Ltd., New Delhi, 2021.

6. Egor P Popov, Engineering Mechanics of Solids, 2nd edition, PHI Learning Pvt. Ltd., New Delhi, 2015.

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	-	2	-	-	-	-	-	-	-	3	-
CO2	-	3	-	3	-	-	-	-	2	-	-	3	-
CO3	-	3	2	-	3	-	-	-		-	-	-	3
CO4	-	3	-	3	-	-	-	-	2	-	-	3	-
CO5	-	3	3	-	2	-	-	-	-	-	-	-	3
Mean	0.6	3	1	1.6	1	-	-	-	0.8	-	-	2.4	1.2

Department : Mechanical Engineering			Programme : B.Tech (ME)						
Semester : Third			Course Category Code: PCC			Semester Exam Type: TY			
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUC106	Materials Technology	L	T	P	C	CA	SE	TM	
		3	-	-	3	40	60	100	
Prerequisite	-								
Course Outcome At the end of the course students will be able to	CO1	illustrate the appropriate engineering materials and composites for industrial applications							
	CO2	explain the different types of steels; demonstrate the construction and applications of Iron –carbon diagram							
	CO3	compare and contrast the different heat treatment processes							
	CO4	select the appropriate material testing method							
UNIT-I	Periods: 9								
Mechanism of Elastic & plastic deformation, Mechanical Properties of materials, hot working-cold working, cooling curves, construction of phase diagrams, Lever rule, Iron-carbon equilibrium diagram, Its Applications, Microscopy, Types of metallurgical microscopes, specimen preparation procedure.								CO1, CO2	
UNIT-II	Periods: 9								
Classification and application of steels & alloy steels, specification of steels. Classification & Effect of alloying elements, Properties and applications of stainless steels, Tool steels and Heat resisting steels-Properties and applications of non- ferrous metals and alloys :Copper, Aluminium, Nickel based alloys								CO1, CO2	
UNIT-III	Periods: 9								
Heat treatment of steels: Annealing, Normalizing, Hardening & Tempering, quenching media, quench cracks, Hardenability& hardenability testing, Defects due to heat treatment and remedial measures. Surface hardening treatments, Carburizing, Nitriding, Flame hardening, and Induction hardening.								CO1, CO3	
UNIT-IV	Periods: 9								
Study of material testing, Tensile test, engineering stress-strain curve, true stress-strain curve, types of stress-strain curves, compression test, different hardness tests-Vickers, Rockwell, Brinell, Micro Hardness Test, Impact test, fatigue test, creep test.								CO1, CO4	
UNIT-V	Periods: 9								
Composite materials: Definition, properties, classification, types of matrix materials and reinforcements, advantages and application of composites. Characteristics and selection of matrix and reinforcements – Introduction to natural fibre composites and Nano-composites								CO1	
Lecture Periods: 45		Tutorial Periods: -		Practical Periods: -		Total Periods: 45			
Reference Books									
1. H.Avner, Introduction to Physical Metallurgy, Tata-McGraw Hill Publishing Co., New Delhi, 2nd Ed., 26th Reprint, 2014.									
2. G.E. Dieter, Mechanical Metallurgy, McGraw Hill Publishing Co., New York, 2012.									
3. R. K. Rajput, Engineering materials and metallurgy, S. Chand and Co Ltd, 2016.									
4. K.K. Chawla, Composite Materials, Science & Engineering, Springer-Verlag, 2006.									
5. Raghavan. V, Physical Metallurgy–Principles and Practice, Prentice Hall India Pvt. Ltd., New Delhi, 2006.									

**CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	-	-	-	-	2	2	-	-	-	2	1	1
<b>CO2</b>	3	-	-	-	-	-	-	-	-	-	-	1	1
<b>CO3</b>	2	-	-	-	-	2	-	-	-	-	-	1	1
<b>CO4</b>	3	-	-	-	-	2	2	-	-	-	-	1	1
<b>Mean</b>	<b>2.8</b>	-	-	-	-	<b>1.5</b>	<b>1</b>	-	-	-	-	<b>1</b>	<b>1</b>

<b>Department: Mechanical Engineering</b>		<b>Programme : B.Tech (ME)</b>						
<b>Semester: Third</b>		<b>Course Category Code: PCC</b>				<b>Semester Exam Type: TY</b>		
<b>Course Code</b>	<b>Course Name</b>	<b>Periods / Week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CA</b>	<b>SE</b>	<b>TM</b>
<b>MEUC107</b>	<b>Machine Drawing and Drafting</b>	<b>2</b>	<b>-</b>	<b>2</b>	<b>3</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>Prerequisite:</b>	Engineering Graphics							
<b>Course Outcome</b> At the end of the course students will be able to	<b>CO1</b>	Apply standard conventions for sectioning, dimensioning, and representation of machine elements such as screw threads, rivets, bolts, nuts, keys, gears, springs, and welds in technical drawings.						
	<b>CO2</b>	Interpret and assign appropriate fits, tolerances, surface finish symbols, and geometrical tolerances in component drawings based on engineering standards.						
	<b>CO3</b>	Develop detailed part drawings and assembly drawings for mechanical components like joints, couplings, bearings, and mechanical devices using manual drafting techniques.						
	<b>CO4</b>	Utilize software for creating, editing, and annotating engineering drawings, ensuring compliance with industrial drafting standards.						
	<b>CO5</b>	Analyze and visualize the functional aspects of mechanical assemblies such as screw jacks, connecting rods, tailstocks, and steam stop valves through detailed engineering drawings.						
<b>PART A</b>	<b>Periods: 30</b>							
Conventions for sectioning and dimensioning, screw threads, rivets, bolts, nuts, pins, keys, cotter, gear, springs and welds. Introduction to geometrical tolerance -Component drawing assigning fits and tolerance machine symbol, GD&T, surface finish. Introduction to AUTOCAD software.								CO1, CO2
<b>PART B</b>	<b>Periods: 30</b>							
Preparation of drawings of parts and assembly of Joints Riveted joints butt joints and lap joints Pin joints knuckle joints Cotter joints -sleeve, socket and spigot joints Couplings Split muff couplings, flexible type flange coupling, universal coupling Bearing Pedestal bearing, swivel bearing, Plummer block Screw jack - Tail stock Connecting rods Steam Stop Valve – Production Drawings								CO3, CO4, CO5
<b>Lecture Periods: 30</b>		<b>Tutorial Periods: -</b>		<b>Practical Periods: 30</b>		<b>Total Periods: 60</b>		
<b>Reference Books:</b>								
1. Ajit Singh, Machine Drawing Includes AutoCAD, Tata McGrawHill Publishing Company Limited, New Delhi, 2008								
2. N. D. Bhatt and V.M. Panchal, Machine Drawing, 51 <sup>st</sup> Edition, Charator Publishers, 2022								
3. Gopalakrishna K.R., Machine Drawing, 17 <sup>th</sup> Edition, Subhas Stores Books Corner, Bangalore, 2003.								
4. BIS, Engineering Drawing Practice for Schools & Colleges, 2003, New Delhi, 2003								
5. Gupta, R.B, Machine Drawing, Satya Prakasham, 1998.								
6. Sidheswar, Machine Drawing, Tata McGraw Hill edition, 2006.								
7. Sadhu Singh and P.L. Sah, Fundamentals of Machine Drawing, PHI 2005.								

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	2	-	-	-	-	-	2	-	1	-	2	-
<b>CO2</b>	3	-	2	-	-	-	-	-	3	-	-	2	-
<b>CO3</b>	3	-	2		2	-	-	-	-	1	-	3	-
<b>CO4</b>	-	-	3	-	-	-	-	-	3	-	-	3	-
<b>CO5</b>	-	3	-	3		-	-	-	-	-	-	-	2
<b>Mean</b>	<b>1.8</b>	<b>1</b>	<b>1.4</b>	<b>0.6</b>	<b>0.4</b>	<b>-</b>	<b>-</b>	<b>0.4</b>	<b>1.2</b>	<b>0.4</b>	<b>-</b>	<b>2</b>	<b>0.4</b>

<b>Department : Humanities and Social Sciences</b>			<b>Programme: B.Tech.</b>						
<b>Semester : Third</b>			<b>Course Category Code:</b>			<b>Semester Exam Type: TY</b>			
			<b>AEC</b>						
<b>Course Code</b>	<b>Course Name</b>		<b>Periods / Week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
			<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CA</b>	<b>SE</b>	<b>TM</b>
<b>HSUA103</b>	<b>Entrepreneurship</b>		<b>2</b>	<b>-</b>	<b>-</b>	<b>2</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>Prerequisite:</b>	<b>-</b>								
<b>Course Outcome</b> At the end of the course students will be able to	<b>CO1</b>	Understand entrepreneurial mind set, problem identification, customer segmentation, and value proposition development.							
	<b>CO2</b>	Develop and validate business models, test solutions, and create a Minimum Viable Product (MVP) through iterative feedback.							
	<b>CO3</b>	Analyze financial planning, revenue models, pricing strategies, and investor expectations for start-up funding.							
	<b>CO4</b>	Apply sales, branding, digital marketing, automation, and teamwork strategies to successfully launch and scale a venture.							
<b>UNIT-I</b>	<b>Problem Identification and Customer Discovery</b>					<b>Periods: 6</b>			
Entrepreneurial mindset – Identifying business opportunities – Effectuation principles – Design Thinking for problem-solving – Consumer segmentation and customer persona – Value Proposition Canvas (VPC) – Unique Value Proposition (UVP) – Market research techniques – Emerging trends: AI in market research.									CO1
<b>UNIT-II</b>	<b>Business Model and Lean Start-up</b>					<b>Periods: 6</b>			
Types of business models – Lean Canvas vs. Business Model Canvas – Competitor analysis – Blue Ocean Strategy – Building and testing Minimum Viable Product (MVP) – Build-Measure-Learn feedback loop – Digital Prototyping tools – Rapid Experimentation – Agile startup methodology.									CO1, CO2
<b>UNIT-III</b>	<b>Revenue Models, Costing, and Financial Planning</b>					<b>Periods: 6</b>			
Revenue models: Subscription, Freemium, and Pay-per-use – Unit economics: Cost structures and pricing strategies – Funding sources: Bootstrapping, Crowdfunding, Venture Capital – Investor expectations and funding rounds – Pitching to investors – Financial forecasting and break-even analysis – Government startup incentives.									CO2, CO3
<b>UNIT-IV</b>	<b>Digital Marketing and Sales Strategies</b>					<b>Periods: 6</b>			
Brand positioning and storytelling – Social media marketing and digital presence – SEO, SEM, and paid advertising – Data-driven marketing strategies – Sales funnels – Unique Sales Proposition (USP) – B2B vs. B2C sales – CRM tools for customer engagement – Customer retention strategies.									CO3, CO4
<b>UNIT-V</b>	<b>Team Building, Compliance, and Scaling</b>					<b>Periods: 6</b>			
Building and managing startup teams – Remote collaboration tools – Business registration and legal compliance – Intellectual Property Rights (IPR) for startups – Growth hacking and automation – Scaling strategies: Expansion and franchising – Emerging trends: AI in entrepreneurship, blockchain applications – Exit strategies: Mergers, acquisitions, IPOs.									CO5
<b>Lecture Periods: 30</b>		<b>Tutorial Periods:-</b>		<b>Practical Periods:-</b>		<b>Total Periods: 30</b>			
<b>Reference Books:</b>									
1. Eric Ries, The Lean Start-up: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses by Crown Business, 1st Edition (2011).									
2. Alexander Osterwalder & Yves Pigneur, Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers, Wiley, 1st Edition (2010).									
3. Ash Maurya, Running Lean: Iterate from Plan A to a Plan That Works, O'Reilly Media, 2nd Edition (2019).									

4. Steve Blank and Bob Dorf, The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company, K&S Ranch, 1st Edition (2012).

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1					1	2	2	2	2	2
CO2	1					1	2	3	3	2	2
CO3	1					1	2	2	3	3	2
CO4	1					1	2	3	3	2	2

Score: 3 – High; 2 – Medium; 1 – Low

Department : Humanities and Social Sciences			Programme: B.Tech.						
Semester : Third			Course		Category	Code:	Semester Exam Type: -		
			VAC						
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
GEUV103	Environmental Education		1	-	-	1	100	-	100
Prerequisite:	-								
Course Outcome At the end of the course students will be able to	CO1	Apply the concept of environment ecology and Education.							
	CO2	Understand the effect of population explosion, degradation of environment and global problem due to the anthropogenic activities.							
	CO3	Comprehend the need of pollution control and sustainable development for future.							
UNIT-I	Introduction to Environmental Education					Periods: 5			
Concept, scope and importance of Environmental Education - Objectives of Environmental Education - Concept of an Ecosystem: Structure and functions, Types of ecosystem (aquatic and terrestrial) - Biodiversity: Levels, values, threats and conservation - Natural resources: Renewable and Non-renewable resources.									CO1
UNIT-II	Environmental degradation and impact					Periods: 5			
Human population growth and its impact on environment - Deforestation: Causes and effects due to expansion of agriculture, firewood, mining and building of new habitats - Pollution: Definition, different types of Pollution - Air and water pollution: Causes and effect on environment - Climate change, Global warming, Ozone layer depletion and impacts on human communities.									CO2
UNIT-III	Conservation of environment					Periods: 5			
Control measures for various types of Pollution: use of renewable and alternate source of energy - Environmental laws: Environmental Protection Act (1986), Water Act (1974), Air Act (1981) - International agreements: Montreal and Kyoto Protocol, Paris Agreement - Concept of sustainable development and SDGs - Role of government, NGOs and individual in environmental conservation.									CO3
Lecture Periods: 15		Tutorial Periods:-		Practical Periods:-			Total Periods: 15		
Reference Books:									
1. Singh, J.S., Singh, S.P. and Gupta, S.R., Ecology, Environmental Science and Conservation, S. Chand Publishing, New Delhi 2014.									
2. Sharma, P. D., Ecology and Environment, Rastogi Publications 2011.									
3. Erach Bharucha, Text Book of Environmental Studies, University Grants Commission, Universities Press (India) Pvt.Ltd., Hyderabad 2010.									

### CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	1	-	-	-	-	3	1	-	-	-	1	1	2
<b>CO2</b>	1	-	-	-	-	3	1	-	-	-	1	1	1
<b>CO3</b>	-	-	-	-	1	3	2	1	-	-	2	1	1
<b>Mean</b>	<b>0.7</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>0.3</b>	<b>3</b>	<b>1.3</b>	<b>0.3</b>	<b>-</b>	<b>-</b>	<b>1.3</b>	<b>1</b>	<b>1.3</b>

Department : Mechanical Engineering				Programme : B.Tech (ME)						
Semester : Third				Course Category Code: PCC				Semester Exam Type: LB		
Course Code	Course Name			Periods/week			Credit	Maximum Marks		
MEUC108	Fluid Mechanics and Hydraulic Machines Laboratory			L	T	P	C	CA	SE	TM
				-	-	2	1	40	60	100
Prerequisite	Fluid Mechanics and Hydraulic Machines theory									
Course Outcome At the end of the course students will be able to	CO1	Make use of the measuring devices for flow measurement								
	CO2	Do performance test on different fluid machinery.								
	CO3	Evaluate the various losses associated with fluid flows.								
	CO4	Analyze and determine the forces exerted by the fluid in dynamics actions.								
	CO5	Understand the performance characteristics of hydraulic machines used in power plants.								
List of Experiments										
1. Determination of Coefficient of discharge of an Orifice Meter 2. Determination of Coefficient of discharge of a Venturi Meter 3. Visualize the type of flow using Reynold’s Experiment 4. Conduct experiment to prove Bernoulli’s Theorem 5. Conduct experiment to determine the forces exerted by a Jet of Fluid on surfaces. 6. Conduct experiment to determine the Frictional Losses in a pipe flow. 7. Conduct experiment to determine the Losses in a flow through Bend, Elbow, Sudden 8. Expansion and Contraction. 9. Conduct experiment to understand the performance characteristics of a Centrifugal Pump. 10. Conduct experiment to understand the performance characteristics of a Submersible Pump. 11. Conduct experiment to understand the performance characteristics of a Reciprocating Pump. 12. Conduct experiment to understand the performance characteristics of a Gear Pump. 13. Conduct experiment to understand the performance characteristics of a Pelton Turbine. 14. Conduct experiment to understand the performance characteristics of a Francis Turbine.										CO1, CO2, CO3, CO4, CO5
Lecture Periods: -		Tutorial Periods:-			Practical Periods: 30			Total Periods: 30		
Reference Books										
1. N. Kumarasamy, Fluid Mechanics and Machinery laboratory manual, Charotar Publishing House Pvt., Ltd., 2012. 2. Dr. S.K. Panigrahi, Ms. L. Mohanty, Fluid Mechanics and Hydraulic Machines Laboratory Manual, S.K. Kataria & Sons, 1st Edition 2023 3. Desmukh T. S., Fluid Mechanics and Hydraulic Machines Laboratory Manual, Laxmi Publications, 2011.										

### CO-PO / PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	2	-	-	-	2	-	-	-	-	-	-	1	1
<b>CO2</b>	2	1	-	-	2	-	-	-	-	-	-	1	-
<b>CO3</b>	2	-	-	-	2	-	-	-	-	-	-	2	1
<b>CO4</b>	2	1	-	-	2	-	-	-	-	-	-	2	1
<b>CO5</b>	2	1	-	-	2	-	-	-	-	-	-	2	2
<b>Mean</b>	2	0.6	-	-	2	-	-	-	-	-	-	1.6	1

Department : Mechanical Engineering			Programme : B.Tech (ME)						
Semester : Third			Course Category Code: PCC			Semester Exam Type: LB			
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUC109	Material Testing and Metallurgy Laboratory	L	T	P	C	CA	SE	TM	
		-	-	2	1	40	60	100	
Prerequisite	Mechanics of solids and materials technology theory								
Course Outcome At the end of the course students will be able to	CO1	Understand iron-carbide diagram and its application in engineering.							
	CO2	Understand metallography and analysis of various metals.							
	CO3	Measure mechanical properties.							
	CO4	Understand differences between various heat treatment methods.							
	CO5	Understand the relation between micro-structure and properties.							
List of Experiments									
1. Study of metallurgical microscope, iron-iron carbide diagram, procedure for specimen preparation 2. Metallographic study of pure iron and low carbon steel 3. Metallographic study of aluminium, brass and bronze 4. Metallographic study of grey cast-iron, white cast-iron, and black heart malleable cast iron 5. Uni-axial tension test to draw stress- strain diagram, and estimate modulus of elasticity and percentage of elongation. 6. Compression test 7. Impact test 8. Brinell hardness test 9. Rockwell hardness test 10. Deflection test on Cantilever beam 11. Shear force & bending moment tests								CO1, CO2, CO3, CO4, CO5	
Lecture Periods: -		Tutorial Periods:-		Practical Periods: 30		Total Periods: 30			
Reference Books:									
1. Smith, Foundations of Materials Science and Engineering, 3rd Edition McGraw Hill, 2009 2. Shackelford., & M. K. Muralidhara, Materials Science, Pearson Publication – 2007. 3. Alan Cottrell, An introduction to Metallurgy, University Press India Oriental Longman Pvt. Ltd., 1974 4. V. Raghavan, Materials Science and Engineering, PHI, 2002 5. H. VanVlack, Elements of Materials Science and Engineering, Addison- Wesley Edn., 1998 6. William D. Callister Jr., Materials Science and Engineering, John Wiley & Sons. Inc, 5th Edition, 2001.									

### CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	2	-	-	-	2	-	1	1	-	-	-	1	1
<b>CO2</b>	2	-	-	-	2	-	1	1	-	-	-	1	1
<b>CO3</b>	2	2	-	-	2	-	1	1	-	-	-	1	1
<b>CO4</b>	2	1	-	-	2	-	1	1	-	-	-	1	1
<b>CO5</b>	2	1	-	-	2	-	1	1	-	-	-	1	1
<b>Mean</b>	2	0.8	-	-	2	-	1	1	-	-	-	1	1

# **SEMESTER – IV**

Department: Mechanical Engineering			Programme : B. Tech (ME)						
Semester: Fourth			Course Category Code: PCC			Semester Exam Type: TY			
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUC110	Renewable Energy Sources	L	T	P	C	CA	SE	TM	
		3	-	-	3	40	60	100	
Prerequisite		Environmental Science and Education, Basic Physics, Chemistry and Mathematics							
Course Outcome At the end of the course students will be able to	CO1	Demonstrate renewable and non-renewable sources of energy							
	CO2	Illustrate about the working principle of various solar energy systems							
	CO3	Experiment with wind energy and wind energy conversion system.							
	CO4	Develop capability to do basic design of bio gas plant.							
	CO5	Understand the applications of different renewable energy sources like ocean thermal, hydro, geothermal energy etc.							
UNIT-I		Introduction to Energy Studies						Periods: 9	
Introduction, Energy science and Technology, Forms of Energy, Importance of Energy Consumption as Measure of Prosperity, Per Capita Energy Consumption, Roles and responsibility of Ministry of New and Renewable Energy Sources, Needs of renewable energy, Classification of Energy Resources, Conventional Energy Resources, Non-Conventional Energy Resources, World Energy Scenario, Indian Energy Scenario.								CO1	
UNIT-II		Solar Energy						Periods: 9	
Introduction, Solar Radiation, Sun path diagram, Basic Sun-Earth Angles, Solar Radiation Geometry and its relation, Measurement of Solar Radiation on horizontal and tilted surfaces, Principle of Conversion of Solar Radiation into Heat, Collectors, Collector efficiency, Selective surfaces, Solar Water Heating system, Solar Cookers, Solar driers, Solar Still, Solar Furnaces, Solar Greenhouse. Solar Photovoltaic, Solar Cell fundamentals, Characteristics, Classification, Construction of module, panel and array. Solar PV Systems (stand-alone and grid connected), Solar PV Applications. Government schemes and policies.								CO2	
UNIT-III		Wind Energy						Periods: 9	
Introduction, History of Wind Energy, Wind Energy Scenario of World and India. Basic principles of Wind Energy Conversion Systems (WECS), Types and Classification of WECS, Parts of WECS, Power, torque and speed characteristics, Electrical Power Output and Capacity Factor of WECS, Stand alone, grid connected and hybrid applications of WECS, Economics of wind energy utilization, Site selection criteria, Wind farm, Wind rose diagram.								CO3	
UNIT-IV		Biomass Energy						Periods: 9	
Introduction, Biomass energy, Photosynthesis process, Biomass fuels, Biomass energy conversion technologies and applications, Urban waste to Energy Conversion, Biomass Gasification, Types and application of gasifier, Biomass to Ethanol Production, Biogas production from waste biomass, Types of biogas plants, Factors affecting biogas generation, Energy plantation, Environmental impacts and benefits, Future role of biomass, Biomass programs in India.								CO4	
UNIT-V		Hydro Power and other Renewable Energy Sources						Periods: 9	
Hydropower: Introduction, Capacity and Potential, Small hydro, Environmental and social impacts. Tidal Energy: Introduction, Capacity and Potential, Principle of Tidal Power, Components of Tidal Power Plant, Classification of Tidal Power Plants. Ocean Thermal Energy:								CO5	

Introduction, Ocean Thermal Energy Conversion (OTEC), Principle of OTEC system, Methods of OTEC power generation. Geothermal Energy: Introduction, Capacity and Potential, Resources of geothermal energy				
<b>Lecture Periods: 45</b>	<b>Tutorial Periods: -</b>	<b>Practical Periods: -</b>	<b>Total Periods: 45</b>	
<b>Reference Books:</b>				
1. B. H. Khan, Non-Conventional Energy Resources, The McGraw Hill 3 <sup>rd</sup> Edition, Chennai, 2017.				
2. G.D. Rai, Non-Conventional Energy Sources, Khanna Publications, New Delhi, 2011.				
3. Twidell, J.W. & Weir, A. Renewable Energy Sources, EFN Spon Ltd., UK, 2006				
4. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K., 1996				
5. Sukhatme. S.P., Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997				
Freris. L.L., Wind Energy Conversion Systems, Prentice Hall, UK, 1990.				

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	2	2	2	1	-	2	2	1	-	1	1	2	1
<b>CO2</b>	2	2	2	1	-	2	2	1	-	1	1	2	1
<b>CO3</b>	2	2	2	1	-	2	2	1	-	1	1	2	1
<b>CO4</b>	2	2	2	1	-	2	2	1	-	1	1	2	1
<b>CO5</b>	2	2	2	1	-	2	2	1	-	1	1	2	1
<b>Mean</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>-</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>-</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>1</b>

<b>Department : Mechanical Engineering</b>		<b>Programme : B.Tech (ME)</b>						
<b>Semester:</b> Fourth		<b>Course Category Code:</b> PCC				<b>Semester Exam Type:</b> TY		
<b>Course Code</b>	<b>Course Name</b>	<b>Periods/week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
<b>MEUC111</b>	<b>Thermal Engineering - I</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CA</b>	<b>SE</b>	<b>TM</b>
		<b>3</b>	<b>1</b>	<b>-</b>	<b>4</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>Prerequisite</b>	Engineering Thermodynamics							
<b>Course Outcome</b>  At the end of the course students will be able to	<b>CO1</b>	explain and analyse thermodynamic cycles for power generation.						
	<b>CO2</b>	explain the limitations and the methods to improve the efficiency of thermodynamic cycles for power generation.						
	<b>CO3</b>	discuss the construction and working of different types of devices for power generation.						
	<b>CO4</b>	discuss and analyse the individual components of power generation.						
	<b>CO5</b>	utilize thermodynamic tables and charts for problem solving.						
<b>UNIT-I</b>	<b>Air standard cycles, Fuels and Combustion</b>						<b>Periods: 12</b>	
Air standard Carnot cycle - Otto cycle, diesel cycle, dual cycle and their comparison – Gas turbine cycle - Brayton cycle and its efficiencies. Fuel properties and their determination - Stoichiometry – reactant and product quantities.							CO1, CO2, CO5	
<b>UNIT-II</b>	<b>IC Engines</b>						<b>Periods: 12</b>	
Classification-Four stroke and two stroke engines- SI and CI Engines-Valve and port timing diagrams. emission norms. Combustion in SI Engines-Ignition Lag-Flame propagation-abnormal Combustion-Knocking. Combustion in CI Engines-Delay period-knocking. Testing of IC engines: Engine performance test - Heat balance test.							CO3	
<b>UNIT-III</b>	<b>Vapour power cycles</b>						<b>Periods: 12</b>	
Rankine cycle without and with reheating, regeneration - binary vapour power cycle. Layout of a modern steam power plant							CO1, CO2, CO3, CO5	
<b>UNIT-IV</b>	<b>Steam turbines and steam nozzles</b>						<b>Periods: 12</b>	
Classification-impulse and reaction turbines-compounding- velocity diagram-work done and efficiencies- stage efficiency. Types-flow of steam through nozzles-condition for maximum discharge – friction-supersaturated flow through nozzle – general relationship between area, velocity and pressure in nozzle flows.							CO4	
<b>UNIT-V</b>	<b>Boilers and Condensers</b>						<b>Periods: 12</b>	
Classification- High pressure boilers-supercritical boilers Classification- Jet condensers and surface condensers- Air removal-vacuum measurement-vacuum and condenser efficiency – cooling water requirement for condensation of steam-Cooling towers and their types.							CO4	
<b>Lecture Periods: 45</b>		<b>Tutorial Periods: 15</b>		<b>Practical Periods: -</b>		<b>Total Periods: 60</b>		
<b>Reference Books:</b>								
1. V. Ganesan, IC Engines, Tata Mc Graw Hill Publication,1995								
2. Kothandaraman, C. P., and Domkundwar, A Course in Thermal Engineering, Dhanpat Rai & Co, 2013.								
3. Cengel, Y.A. and Boles, M.A., "Thermodynamics - An Engineering Approach", 7th edition, Tata Mc-Graw Hill Education, 2011.								
4. John B Heywood, IC engine Fundamentals, McGraw Hill International Edition,1988								
5. Collin R. Ferguson–Internal Combustion Engines-Applied Thermo sciences, Wiley, 2004.								

6. Willard W. Pulkrabek– Internal Combustion Engines, Prentice Hall of India, 2002

### **CO-PO Mapping**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PSO1</b>	<b>PSO2</b>
<b>CO1</b>	2	3	1	-	-	-	-	-	-	-	-	3	2
<b>CO2</b>	-	3	-	-	-	2	-	-	-	-	-	2	3
<b>CO3</b>	3	2	1	-	-	-	-	-	-	-	-	2	3
<b>CO4</b>	3	2	1	-	-	-	-	-	-	-	-	3	2
<b>CO5</b>	-	2	1	-	3	-	-	-	-	-	-	3	2
<b>Mean</b>	<b>1.6</b>	<b>2.4</b>	<b>0.8</b>	<b>-</b>	<b>0.6</b>	<b>0.4</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>2.6</b>	<b>2.4</b>

Department : Mechanical Engineering		Programme : B.Tech (ME)						
Semester : Fourth		Course Category Code: PCC				Semester Exam Type: TY		
Course Code	Course Name	Periods/week			Credit	Maximum Marks		
MEUC112	Kinematics of Machines	L	T	P	C	CA	SE	TM
		3	1	-	4	40	60	100
Prerequisite	-							
Course Outcome  At the end of the course students will be able to	CO1	Understand and visualise any given practical machines as simple kinematic chain and its kinematic effect of geometry of profile/ dimensional details of linkages on the motion of machine elements.						
	CO2	Carry out motion analysis and synthesis at any point on the given mechanism and can applied them to solve for design requirement.						
	CO3	Design mechanism/ machine element for new product development						
	CO4	Understand the importance of manufacturing consideration in developing mechanism						
UNIT-I	Introduction					Periods: 12		
Mechanisms and machines; Elements of kinematic chain, mobility and range of movements, Definition & Concept - inversion of single and double slider chain and four bar chain and its applications. Mechanism with lower pairs -Pantograph, Straight line mechanism- exact and approximate Motion, Motor car Steering gears, Hooke joint.							CO1	
UNIT-II	Kinematic analysis of mechanisms					Periods: 12		
Analysis of displacement, velocity & acceleration diagrams of simple planar mechanisms by graphical (Instantaneous centre method and relative velocity method), analytical and computer aided methods (for four-bar and slider crank mechanism only), Coriolis component of acceleration.							CO1, CO2	
UNIT-III	Kinematic synthesis of mechanisms					Periods: 12		
Kinematic synthesis, graphical method using relative pole method, Inversion method and overlay method, 3-point synthesis problems - Motion, function generation, Chebyshev's spacing of accuracy points. Freudenstein Method of 3-point synthesis of four link mechanism and slider crank mechanism.							CO1, CO2, CO3	
UNIT-IV	Cams					Periods: 12		
Types of cams and followers, displacement velocity and acceleration curves for uniform velocity, uniform acceleration and retardation, SHM, cycloidal motion, layout of profile of plate cams of the above types with reciprocating, oscillating, knife-edge, roller and flat faced followers. Cylindrical and face cams, cams with special contours. Tangent cams with reciprocating roller follower, circular arc cam with flat faced follower.							CO2, CO3, CO4	
UNIT-V	Gears and Gear Trains					Periods: 12		
Classification and terminology used, Fundamental law of gearing – friction wheel, teeth for positive action and condition for constant velocity ratio. Conjugate profiles, cycloidal and involute teeth profiles. Involute construction, properties and computation of path of contact and contact ratio. Interference and undercutting- Minimum number of teeth to avoid Interference, methods to avoid Interference. Introduction, classification, examples, gear ratio in simple and compound gear trains, Automobile gear box, Planetary gear trains-methods of evaluating gear ratio - Differential gear box							CO1, CO3, CO4	
Lecture Periods: 45		Tutorial Periods: 15		Practical Periods: -		Total Periods: 60		

**Reference Books:**

1. Rattan S. S., Theory of Machines, McGraw Hill Education; Fourth edition, 2017
2. Amitabha Ghosh and Ashok Kumar Mallik, Theory of Mechanisms and Machines, East West Press Pvt. Ltd., New Delhi, 2000
3. Shigley J. E. and John Joseph Uicker, Theory of Machines and Mechanisms, 2nd edition McGraw-Hill international edition, 2003
4. Reuleaux F, The Kinematics of Machinery: Outlines of a Theory of Machines, Forgotten Books, 2018

**CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	2	-	-	-	-	-	-	-	-	-	1
CO2	3	3	2	-	-	-	-	-	-	-	-	3	-
CO3	1	-	1	-	-	-	-	2	-	-	-	-	2
CO4	1	1	2	-	-	-	-	2	-	-	-	2	-
Mean	2	2	1.8	-	-	-	-	2	-	-	-	2.5	1.5

Department: Mechanical Engineering			Programme: B.Tech (ME)						
Semester: Fourth			Course Category Code: PCC				Semester Exam Type: TY		
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUC113	Manufacturing Processes	L	T	P	C	CA	SE	TM	
		3	-	-	3	40	60	100	
Prerequisite	-								
Course Outcome At the end of the course students will be able to	CO1	Explain the steps and equipment's involved in casting, welding and metal forming operations							
	CO2	Study the importance of various surface finishing processes with respect to industrial application							
	CO3	Illustrate the need for Polymer materials in engineering and apply different manufacturing methods for producing Plastics and Polymer products							
	CO4	Make use of different Manufacturing Processes/ Finishing techniques to convert metals, alloys, Plastics and Polymers to produce industrial products							
UNIT-I	Periods: 9								
Introduction to Manufacturing processes-classification, steps involved in casting process, different types of casting- pattern and core making-materials, types, and allowances – moulding tools and equipment-properties of moulding sand- casting defects and remedies							CO1, CO4		
UNIT-II	Periods: 9								
Types of welding processes- weldability-gas welding- oxy acetylene welding – Arc welding-types and equipment -Resistant welding-types and application, welding dissimilar and non-metals- welding defects							CO1, CO4		
UNIT-III	Periods: 9								
Classification of metal forming processes- Rolling, Forging, Extrusion, Drawing and Sheet metal operations; terminology used, processes, machines, and defects.							CO1, CO4		
UNIT-IV	Periods: 9								
Surface finishing processes- surface finish and surface roughness- Honing, Lapping, Superfinishing, Abrasive belt finishing, Mass finishing process -Polishing , Buffing, Grinding- Types, Grinding operations							CO2, CO4		
UNIT-V	Periods: 9								
Plastics and Polymers- structure of polymers- additive in Plastics- thermoplastics and thermosetting plastics- manufacturing of plastics- different moulding methods- forming/shaping methods- joining of plastics- industrial application of plastics							CO3, CO4		
Lecture Periods: 45		Tutorial Periods: -		Practical Periods: -		Total Periods: 45			
Reference Books:									
1. S.K. Hajra Choudry- Workshop Technology, Vol. I & II, Media Promoters and Publishers Pvt. Ltd., 1997									
2. J.P.Kaushish – Manufacturing Processes, Prentice Hall India Pvt. Ltd., 2008									
3. B.S.Nagendra Parashar & R.K. Mittal – Elements of Manufacturing Processes – Prentice Hall India Pvt. Ltd., 2003									
4. Roy A Lindberg – Processes and Materials of Manufacture, Prentice Hall India Pvt. Ltd., 2002									
5. E.Paul DeGarmo, Ronald A. Kosher – Materials and Processes in Manufacturing, Prentice Hall India Pvt. Ltd., 2008									

### **CO-PO Mapping**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PSO1</b>	<b>PSO2</b>
<b>CO1</b>	2	-	2	-	-	1	-	-	-	-	-	-	1
<b>CO2</b>	2	-	1	-	-	1	-	-	-	-	-	-	1
<b>CO3</b>	2	-	2	-	-	-	-	-	-	-	-	-	1
<b>CO4</b>	3	2	3	-	-	-	-	-	-	-	1	-	2
<b>Mean</b>	<b>2.3</b>	<b>0.5</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>0.5</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>0.3</b>	<b>-</b>	<b>1.3</b>

Department : Humanities and Social Sciences			Programme: B.Tech.						
Semester : Fourth			Course Category Code: AEC			Semester Exam Type: TY			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
HSUA104	Design Thinking		2	-	-	2	40	60	100
Prerequisite:									
Course Outcome At the end of the course students will be able to	CO1	Apply Design Thinking to solve engineering problems							
	CO2	Produce creative solutions for real-world problems using brainstorming and other idea-generation techniques							
	CO3	Build and test prototypes to validate design ideas and improve them based on user feedback.							
	CO4	Collaborate work in teams and communicate ideas effectively through presentations, reports, and discussions.							
UNIT-I		Introduction to Design Thinking				Periods: 6			
Understanding the Need for Design Thinking in Engineering - Five-Stage Process: Empathize, Define, Ideate, Prototype, Test - Case Studies: How Engineering Innovations Used Design Thinking - Mindset Shift: From Problem-Solving to Human-Centered Design <b>Team Exercise:</b> Identify a real-world engineering problem and discuss how Design Thinking can be applied.									CO1, CO4
UNIT-II		Empathize				Periods: 6			
Importance of User Research in Engineering Solutions - Techniques: Interviews, Observations, Surveys, Empathy Mapping - Engineering Constraints vs. User-Centric Needs - Role of Emotional Intelligence in Product Development <b>Team Exercise:</b> Conduct field research (interview users or observe a process) and create an Empathy Map for an engineering challenge.									CO1, CO2
UNIT-III		Define & Ideate				Periods: 6			
Problem Definition Techniques: How to Frame the Right Problem - Creating Point of View (POV) Statements - Brainstorming & Idea Generation Techniques: SCAMPER, Reverse Thinking, Mind Mapping - Evaluating and Selecting Feasible Engineering Solutions <b>Team Exercise:</b> Define a problem statement and conduct a Brainstorming Workshop to generate innovative solutions.									CO2, CO4
UNIT-IV		Prototyping				Periods: 6			
Importance of Rapid Prototyping in Engineering - Types of Prototypes: Paper, Digital, Physical Models, Simulation - Tools & Technologies: 3D Printing, CAD, Arduino, Low-Code Development - Iteration & Refinement – Learning from Failures <b>Team Exercise:</b> Develop a low-fidelity prototype of an engineering solution and present it to peers for feedback.									CO3, CO4
UNIT-V		Testing, Iteration & Implementation				Periods: 6			
Methods of Testing: Usability Testing, A/B Testing, Stress Testing - Gathering Feedback: Stakeholder & User Insights - Iteration Strategies: Continuous Improvement & Agile Thinking - Real-World Engineering Applications of Design Thinking <b>Team Exercise:</b> Conduct a user test on the prototype, refine it based on feedback, and present the final solution in a showcase session.									CO3, CO4
Lecture Periods: 30		Tutorial Periods:		Practical Periods:			Total Periods: 30		
Reference Books:									
1. Michael Lewrick, Patrick Link, and Larry Leifer, The Design Thinking Toolbox: A Guide to Mastering the Most Popular and Valuable Innovation Methods, Wiley, 1st Edition, 2020.									
2. Teun den Dekker, Design Thinking, Noordhoff Uitgevers bv, International Edition, 2020									

3. Angèle M. Beausoleil, Business Design Thinking and Doing, Palgrave Macmillan Imprint, Springer, 2022
4. Soni Pavan, Design your Thinking, Penguin Random House India Publishing, 2020
5. E Balagurusamy, Design Thinking, McGraw Hill; First Edition, 2024

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	3	2	2	2	2	1	2	1	2	3	1	1
<b>CO2</b>	3	3	3	2	2	2	-	2	3	2	3	1	1
<b>CO3</b>	3	2	3	3	3	2	1	3	2	3	3	1	1
<b>CO4</b>	-	-	3	2	-	2	3	3	3	3	2	1	1
<b>Mean</b>	<b>2.2</b>	<b>2</b>	<b>2.9</b>	<b>2.2</b>	<b>1.8</b>	<b>2</b>	<b>1.2</b>	<b>2.5</b>	<b>2.2</b>	<b>2.4</b>	<b>2.8</b>	<b>1</b>	<b>1</b>

<b>Department : Humanities and Social Sciences</b>			<b>Programme: B.Tech.</b>						
<b>Semester : Fourth</b>			<b>Course Category Code: AEC</b>			<b>Semester Exam Type: TY</b>			
<b>Course Code</b>	<b>Course Name</b>		<b>Periods / Week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
			<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CA</b>	<b>SE</b>	<b>TM</b>
<b>HSUA106</b>	<b>Language- French</b>		<b>2</b>	<b>-</b>	<b>-</b>	<b>2</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>Prerequisite:</b>									
<b>Course Outcome</b> At the end of the course students will be able to	<b>CO1</b>	Acquire the basics of the French language							
	<b>CO2</b>	Apply the acquired basics of the language in expressing oneself							
	<b>CO3</b>	Develop basic conversation skills							
	<b>CO4</b>	Communicate their student life in the University context							
	<b>CO5</b>	Equip the students to communicate within technical contexts							
<b>UNIT-I</b>	<b>Introduction to French and basics</b>					<b>Periods: 6</b>			
French alphabets and pronunciation – Greetings and Introductions (Bonjour ça va?) – Numbers, days of the week, months, seasons – Classroom expressions and instructions – Articles (Definite and Indefinite) – Basic sentence structure (Subject – Verb Agreement)									<b>CO1</b>
<b>UNIT-II</b>	<b>Personal Identity and Expressions</b>					<b>Periods: 6</b>			
Introducing oneself and others (Je me présente.....) – Nationalities and Professions – Describing people (Physical appearance and Personality) – Possessive adjectives (mon, ma, mes...) – Gender and number agreement of adjectives									<b>CO2</b>
<b>UNIT-III</b>	<b>Daily life and Routines</b>					<b>Periods: 6</b>			
Talking about daily activities and schedules (Je me lève à 7 heures...) – Telling the time and discussing time tables – Common verbs in the present tense (ER, IR, RE verbs) – Reflexive verbs (Se lever, s’habiller...)									<b>CO3</b>
<b>UNIT-IV</b>	<b>Directions and University life</b>					<b>Periods: 6</b>			
Asking for and giving directions (Où est....? A gauche, A droite...) – Describing locations ( Près de, loin de....)- Talking about University courses and subjects (J’étudie l’ingénierie...) - Prepositions of place (sur, sous, devant....) – Using Il y a and C’est for descriptions									<b>CO4</b>
<b>UNIT-V</b>	<b>Future plans,technical presentations in engineering contexts</b>					<b>Periods: 6</b>			
Talking about future career goals (Je veux devenir ingénieur.....) Using future proche for near future plans- Vocabulary related to Engineering disciplines – Talking about machines and materials (Acier, moteur, circuit....) – Giving simple presentations on technical topics – Introduction to passive voice (La machine est réparée....)									<b>CO5</b>
<b>Lecture Periods: 30</b>		<b>Tutorial Periods: -</b>		<b>Practical Periods:-</b>			<b>Total Periods: 30</b>		
<b>Reference Books:</b>									
1. Nouvelle Generations A1, Luca Giachino, Carla Baracoo, Didier FLE, 2020, Paris									
2. Tech French – French for Science and Technology, Ingrid Le Gargasson, Shariva Naik et Claire Chaize, Goyal Publishers, 1 April 2011.									
3. Écho – Méthode de Français, A1 , Girardet, Pecheur, CLE International,2013.									
4. Écho Cahier personnel d’apprentissage, A1, Girardet, Pecheur, CLE International, 2013.									

### CO-PO Mapping

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PSO1</b>	<b>PSO2</b>
<b>CO1</b>	-	-	-	-	-	-	-	3	3	-	3	-	-
<b>CO2</b>	-	-	-	-	-	-	-	3	3	-	3	-	-
<b>CO3</b>	-	-	-	-	-	-	-	3	3	-	3	-	-
<b>CO4</b>	-	-	-	-	-	-	-	3	3	-	3	-	-
<b>CO5</b>	-	-	-	-	-	-	-	3	3	-	3	-	-
<b>Mean</b>	-	-	-	-	-	-	-	3	3	-	3	-	-

Department : Humanities and Social Sciences				Programme: B.Tech.						
Semester : Fourth				Course Category Code: VAC			Semester Exam Type:			
Course Code	Course Name:			Periods / Week			Credit	Maximum Marks		
				L	T	P	C	CA	SE	TM
GEUV104	Universal Human Values			1	0	0	1	100	-	100
Prerequisite:	-									
Course Outcome At the end of the course students will be able to	CO1	Develop a holistic understanding of value education.								
	CO2	Foster personal and social harmony.								
	CO3	Enhance awareness of universal co-existence.								
	CO4	Apply ethical and humanistic principles in professional and personal life.								
Unit-I	Introduction to Value Education						Periods: 3			
Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfil the Basic Human Aspirations										CO1
Unit-II	Harmony in the Human Being						Periods: 3			
Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health										CO2
Unit-III	Harmony in the Family and Society						Periods: 3			
Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human to Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order										CO2
Unit-IV	Harmony in the Nature/Existence :						Periods: 3			
Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence										CO3
Unit-V	Implications of the Holistic Understanding						Periods: 3			
A Look at Professional Ethics : (3 hours) Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession										CO4
Lecture Periods: 15		Tutorial Periods: -		Practical Periods:-			Total Periods: 15			
Reference Books:										
1. Student Induction Program Handbook, AICTE NCC-IP sub-committee: Dr. Rajneesh Arora, Chairman NCC-IP, Dr. Shishir Gaur, Convener NCC-IP, Dr. Ruchir Gupta, Member NCC-IP. 2. R R Gaur R Asthana G P Bagaria, A foundation course in human values and professional ethics. 3. UHV Team, Understanding Human Being, Nature and Existence Comprehensively ( <a href="https://uhv.org.in/uhve">https://uhv.org.in/uhve</a> ) 4. RR Gaur, R Asthana, GP Bagaria, Teacher Manual for A Foundation Course in Human Values and Professional Ethics .										

**CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1						3	3	2	2	2	3
CO2						3	3	3	3	2	3
CO3						3	3	2	2	2	3
CO4						3	3	2	2	3	3

Department : Mechanical Engineering			Programme : B.Tech (ME)						
Semester : Fourth			Course Category Code: PCC			Semester Exam Type: LB			
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUC114	Dynamics of Machines Laboratory	L	T	P	C	CA	SE	TM	
		-	-	2	1	40	60	100	
Prerequisite	-								
Course Outcome At the end of the course students will be able to	CO1	Understand and demonstrate the importance of Kinematic studies and motion analysis							
	CO2	Determine of mass properties and comparing with theoretical results							
	CO3	Determine natural frequencies of given vibration system and comparing with theoretical results							
	CO4	Demonstrate the load management and stability of machines.							
Exercises on kinematic studies and motion analysis									
1. Demonstration of four bar inversion mechanism 2. Tracing of coupler curves. 3. Determination of error in straight line drawn by watt chain mechanism. 4. Generation of involute gear profile. 5. Cam motion analysis.								CO1, CO2	
Exercises to determine of mass properties experimentally									
6. Determination of radius of gyration of a given compound pendulum –(i) Rectangular bar (ii) trapezium bar (iii) Connecting rod 7. Determination of radius of gyration, moment of inertia – bifilar suspension method – trifilar suspension method								CO2	
Exercises to determine natural frequencies of given vibration systems									
8. Natural frequency of single mass, single helical spring system. 9. Natural frequency of combination of springs – springs in parallel, springs in series 10. Natural frequency of un-damped torsional single rotor, double rotor system. Effect of inertia (I) and stiffness (k). 11. Resonance frequency of equivalent spring mass system – un-damped and damped condition (a)To plot amplitude Vs frequency graph for different damping. 12. Damping coefficient of torsional single rotor system – Effect of depth of immersion in oil and damping ratio 13. Whirling of shafts/ determination of critical speed with and without Rotors.								CO1, CO2 CO3	
Exercises to understand load management and stability studies.									
14. Determination of characteristic curves of Watt, Porter, Proell and spring loaded governors. 15. Gyroscopic couple verification. 16. Static and Dynamic balancing. 17. Journal bearing – pressure distribution of different loads at different speeds								CO1, CO2, CO4	
Tutorial Periods: -		Tutorial Periods: -		Practical Periods: 30		Total Periods: 30			
Reference Books:									
1. J.S.Rao and R.V.Dukkipati - Mechanism and Machine Theory, New Age International, 2010. 2. Thomas Bevan - Theory of Machines, Pearson Education, 2010. 3. P.L.Ballaney - Mechanics of Machines, Khanna Publishers, 2009. 4. S. S. Rattan - Theory of Machines, Tata Mc graw Hill Publisher, 5th Edition ,2019 5. R.S. Khrumi - A Textbook of Theory of Machine, S Chand Publisher, 2020									

**CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	2	2	-	-	-	-	-	2	2	-	-	2	-
<b>CO2</b>	2	2	-	-	-	-	-	2	2	-	-	2	-
<b>CO3</b>	2	2	-	-	-	-	-	2	2	-	-	2	-
<b>CO4</b>	2	2	-	-	-	-	-	2	2	-	-	2	-
<b>Mean</b>	<b>2</b>	<b>2</b>	-	-	-	-	-	<b>2</b>	<b>2</b>	-	-	<b>2</b>	-

Department : Mechanical Engineering			Programme : B.Tech (ME)						
Semester : Fourth			Course Category Code: PCC				Semester Exam Type: LB		
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUC115	Manufacturing Processes Laboratory		L	T	P	C	CA	SE	TM
			-	-	2	1	40	60	100
Prerequisite	-								
Course Outcome  At the end of the course students will be able to	CO1	Identify various tools and machinery used in workshop							
	CO2	Explain the working principle of welding and foundry processes							
	CO3	Explain the application of fitting, welding and foundry							
Fitting shop 1. Study of tools used in fitting shop 2. Symmetric fitting 3. Acute angle fitting 4. Obtuse angle fitting								CO1, CO3	
Welding shop 5. Study of tools and apparatus used in welding shop 6. V-Butt joint 7. Lap joint 8. Corner joint								CO1, CO2, CO3	
Foundry shop 9. Study of tools, materials used in foundry shop 10. Mould preparation using solid pattern 11. Mould preparation using split pattern,								CO1, CO2, CO3	
12. Power tools								CO1	
Lecture Periods: -		Tutorial Periods: -		Practical Periods: 30			Total Periods: 30		
Reference Books: 1. Veeranna D.K., Workshop / Manufacturing Practices (with Lab Manual), AICTE Prescribed Textbook (English)by All India Council for Technical Education (AICTE), 2022									

### CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	-	-	-	3	2	-	1	-	-	2	2	2
<b>CO2</b>	3	-	-	-	1	2	-	1	-	-	1	2	2
<b>CO3</b>	1	-	-	-	-	-	-	-	-	-	-	-	-
<b>Mean</b>	<b>2.3</b>	-	-	-	<b>1.3</b>	<b>1.3</b>	-	<b>0.7</b>	-	-	<b>1</b>	<b>1.3</b>	<b>1.3</b>

# **SEMESTER – V**

Department : Mechanical Engineering			Programme : B.Tech (ME)						
Semester : Fifth			Course Category Code: PCC			Semester Exam Type: TY			
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUC116	Heat and Mass Transfer		L	T	P	C	CA	SE	TM
			3	1	-	4	40	60	100
Prerequisite	-								
Course Outcome At the end of the course students will be able to	CO1	Explain the laws and governing equations of different modes of heat and mass transfer							
	CO2	Formulate and solve problems in heat transfer and mass transfer							
	CO3	Make use of analytical equations, empirical equations, appropriate tables and charts to solve problems							
	CO4	Explain the significance of non-dimensional numbers in heat and mass transfer							
UNIT-I	Conduction: I								Periods: 12
Introduction to heat transfer- different modes of heat transfer. Fourier's law of conduction – general equation in cartesian, cylindrical and spherical co-ordinates-one dimensional steady state conduction in plane wall, composite wall, composite cylinder and sphere- thermal contact resistance-overall heat transfer coefficient–critical thickness of insulation								CO1,CO2, CO3, CO4	
UNIT-II	Conduction: II								Periods: 12
Fins-pin fins, annular fins and longitudinal fins-unsteady state conduction-lumped heat capacity system-conduction with heat sources-Biot number, Fourier number, semi-infinite –infinite solids system-Heisler's chart								CO1, CO2, CO3, CO4	
UNIT-III	Convection and condensation:								Periods: 12
Forced convection: External flow: laminar and turbulent flow over a flat plate, cylinder and sphere. Internal flow: laminar and turbulent flow through circular tubes. Free convection: laminar flow over vertical, horizontal and inclined surfaces. Condensation: Film-wise and drop-wise condensation, film-wise condensation outside vertical and horizontal surfaces. Boiling heat transfer: regimes of boiling –nucleate boiling, film boiling								CO1, CO2, CO3, CO4	
UNIT-IV	Heat exchangers:								Periods: 12
Types of heat exchangers- double pipe heat exchangers, parallel and counter flows heat exchangers. Log Mean Temperature Difference (LMTD) – multi pass heat exchangers, Analysis using correction factors-effectiveness–effectiveness expressed in terms of NTU for different configurations – effectiveness Vs NTU charts								CO1, CO2, CO3, CO4	
UNIT-V	Radiation and mass transfer								Periods: 12
Heat Transfer by radiation: nature of thermal radiation-black body, Stefan-Boltzman law, Kirchoff's law, intensity of radiation- analysis of heat exchange between surfaces by radiation-shape factor-grey body radiation between surfaces separated by non-absorbing medium. Introduction to mass transfer-similarity between heat transfer and mass transfer. Fick's law of diffusion, significance of non-dimensional numbers in mass transfer								CO1, CO2, CO3, CO4	
Lecture Periods: 45		Tutorial Periods: 15		Practical Periods: -			Total Periods: 60		
Reference Books:									
1. R.K Rajput, Heat and mass transfer, fifth revised edition 2012, Chand & Company Ltd.									
2. R. C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, New Age Science, 2009									
3. Yunus A. Cengel.Afshin J. Ghajar, Heat and mass transfer, Published by McGraw –Hill Education									

- 2015

4. Incropera, F.P. and Dewitt, D. P., Fundamentals of Heat and Mass Transfer, IV Edition, John Wiley & Sons, 2000.
5. Bejan, A., Heat Transfer, John Wiley & Sons, 1993,
6. Holman, J.P., Heat Transfer, X Edition, McGraw Hill Book Company, NY, 2009

### **CO-PO MAPPING**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PSO1</b>	<b>PSO2</b>
<b>CO1</b>	3	1	1	-	-	-	-	-	-	-	-	1	1
<b>CO2</b>	3	2	1	1	-	-	-	-	-	-	-	2	-
<b>CO3</b>	-	2	2	-	-	-	-	-	-	-	2	2	2
<b>CO4</b>	2	2	-	-	-	-	-	-	-	-	-	2	-
<b>Mean</b>	<b>2</b>	<b>1.8</b>	<b>1</b>	<b>0.3</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>0.5</b>	<b>1.8</b>	<b>0.8</b>

Department : Mechanical Engineering			Programme : B.Tech (ME)						
Semester : Fifth			Course Category Code: PCC			Semester Exam Type: TY			
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUC117	Dynamics of Machines	L	T	P	C	CA	SE	TM	
		3	1	-	4	40	60	100	
Prerequisite	-								
Course Outcome At the end of the course students will be able to	CO1	explain inertial force effect in designing of machines							
	CO2	explain techniques of stability and control of machines.							
	CO3	demonstrate and solve problems on vibration source control techniques							
	CO4	demonstrate techniques to attenuate or eliminate evil effects of vibration							
UNIT-I	Periods: 12								
D'Alembert's Principle-Inertia forces of reciprocating parts, Dynamic analysis of four link and slider-crank mechanisms, Engine force Analysis Turning moment on crankshaft, Dynamically Equivalent system, Inertia forces in a reciprocating engine , Turning Moment diagrams, Fluctuations of Energy and speed, Flywheel.							CO1, CO2		
UNIT-II	Periods: 12								
Basic concepts of S.H.M, Causes and effects of vibration and degrees of freedom. Natural frequency of free oscillations – equivalent system – energy method – simple problems, damped free vibration of single degree of freedom system, forced vibration. Basic of vibration isolation, Transmissibility and vibration absorbers.							CO3, CO4		
UNIT-III	Periods: 12								
Transverse vibrations of Beams-Natural frequency by energy method, Dunkerly's method, Whirling of shafts calculation of whirling speed for loaded shafts. Torsional vibrations-causes of Torsional vibration. Torsional Vibration of two and three rotor systems. Equivalent shaft system, Geared system.							CO3, CO4		
UNIT-IV	Periods: 12								
Governors - Types - Centrifugal governors - Gravity controlled and spring controlled centrifugal governors – Characteristics - Effect of friction - Controlling Force - other Governor mechanisms. Gyroscopes - Gyroscopic forces and Torques - Gyroscopic stabilization - Gyroscopic effects in Automobiles, ships and airplanes.							CO1, CO2		
UNIT-V	Periods: 12								
Static and dynamic balancing of rotating masses in different planes - partial balancing of reciprocating masses of inline, V, W and radial engines.							CO1, CO3		
Lecture Periods: 45		Tutorial Periods: 15		Practical Periods: -		Total Periods: 60			
Reference Books:									
1. Rattan S. S., Theory of Machines, McGraw Hill Education; Fourth edition (2017)									
2. J.S. Rao and R.V. Dukkupati - Mechanism and Machine Theory, New Age International, 2010.									
3. Shigley J. E. and John Joseph Uicker, Theory of Machines and Mechanisms, 2nd edition McGraw-Hill international edition (2003)									
4. Reuleaux F, The Kinematics of Machinery: Outlines of a Theory of Machines, Forgotten Books (2018)									
5. P.L.Ballaney - Mechanics of Machines, Khanna Publishers, 2005.									
6. Thomas Bevan - Theory of Machines, CBS Publishers & Distributors, 2004.									

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	1	1	1	-	-	-	1	-	-	-	-	2
<b>CO2</b>	3	1	1	1	-	-	-	1	-	-	-	-	2
<b>CO3</b>	3	-	1	-	-	-	-	1	-	-	-	2	-
<b>CO4</b>	3	2	2	-	-	-	-	1	-	-	-	2	-
<b>Mean</b>	<b>3</b>	<b>1</b>	<b>1.3</b>	<b>0.5</b>	-	-	-	<b>1</b>	-	-	-	<b>1</b>	<b>1</b>

Department : Mechanical Engineering			Programme : B.Tech (ME)						
Semester : Fifth			Course Category Code: PCC			Semester Exam Type: TY			
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUC118	Metrology and Measurements		L	T	P	C	CA	SE	TM
			4	-	-	4	40	60	100
Prerequisite	-								
Course Outcome  At the end of the course students will be able to	CO1	Understand principles of metrology and measurements							
	CO2	Demonstrate various measuring instruments and equipment							
	CO3	Demonstrate the selection and application of measuring systems							
	CO4	Understand recent advances in metrology							
UNIT-I	Basic Principles and Basic Elements of Metrology							Periods: 12	
Basics: Definition-Categories: scientific metrology, industrial metrology, legal metrology. Need of inspection, revision of precision, accuracy, sensitivity, readability, calibration, traceability, reproducibility. Sources of errors, factors affecting accuracy, selection of instrument, precautions while using instruments for getting higher precision and accuracy, Standards and Comparators: Definition and introduction to line standard - end standard, Wave length standard, Slip gauge and its accessories, Length bars. requirement of good comparator, Classification, use of comparators, working principle of comparators, Relative advantages and disadvantages								CO1, CO2	
UNIT-II	Applications of Metrology							Periods: 12	
Concept- instruments for angular measurements, working and use of universal bevel protractor, sine bar, spirit level, clinometers, angle gauges. Screw thread measurements: measuring elements of screw thread using two wire method. Gear measurement and testing: rolling test, constant chord method, gear tooth Vernier.								CO1, CO2	
UNIT-III	Advanced Metrology							Periods: 12	
Basic concept of lasers Advantages of lasers, laser Interferometers, types, DC and AC Lasers interferometer, Applications — Straightness, Alignment. Basic concept of CMM, Types of CMM, Constructional features, Probes, Accessories, Software, Applications, Basic concepts of Machine Vision System, Element, Applications. Form measurement: Principles and Methods of straightness, Flatness measurement, surface finish measurement, Roundness measurement — Applications								CO1, CO2, CO4	
UNIT-IV	Basic Principles and Elements of Mechanical Measurement Systems							Periods: 12	
Significance of measurement, types of measurement, classification of instruments, Static terms and characteristics- range and span, accuracy and precision, reliability, calibration, hysteresis and dead zone, drift, sensitivity, threshold and resolution, repeatability and reproducibility, linearity. Dynamic characteristics-speed of response, fidelity and dynamic errors, overshoot. Measurement of error: classification: environmental errors, signal transmission errors, observation errors, operational errors. Transducers: Classification of transducers, active and passive, resistive, inductive, capacitive, piezo-resistive, thermo- resistive.								CO1 CO2, CO3	
UNIT-V	Applications of Mechanical Measurement							Periods: 12	
Displacement measurement: Capacitive transducer, Potentiometer, LVDT, RVDT, Specification, selection & application of displacement transducer. Force, torque, power — mechanical, Pneumatic, Hydraulic and Electrical type. Temperature measurements:								CO1, CO2, CO3	

Non-electrical methods-bi metal and liquid in glass thermometer, pressure thermometer. Electrical methods-RTD, platinum resistance thermometer, thermistor, Thermo-electric methods. Elements of thermocouple, law of intermediate temperature, law of intermediate metals, thermo emf measurement. Quartz thermo-meter, Pyrometers-radiation and optical.	
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<b>Lecture Periods: 45</b>	<b>Tutorial Periods: 15</b>	<b>Practical Periods: -</b>	<b>Total Periods: 60</b>
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**Reference Books:**

1. R.K.Jain, Engineering Metrology, Khanna Publishers, Special edition, 2022
2. N.V. Ragvendra and L. Krishnamurthy, Engineering Metrology and Measurements, Oxford publishers, 2013
3. I.C.Gupta, A text book of Engineering Metrology, Dhanpat Rai PublicationS,2019
4. R.C.Gupta, Statistical Quality Control & Quality Management, Khanna Publishers, 1998

**CO-PO MAPPING**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	1	-	-	1	-	-	-	-	-	1	1	1
CO2	3	1	-	-	1	-	-	-	-	-	1	1	1
CO3	3	-	-	-	-	-	-	-	-	-	-	1	1
CO4	3	2	-	1	2	-	-	-	-	-	1	2	2
Mean	3	1	-	0.3	1	-	-	-	-	-	0.8	1.3	1.3

Department : Mechanical Engineering			Programme : B.Tech (ME)					
Semester: Fifth			Course Category Code: PCC			Semester Exam Type: TY		
Course Code	Course Name	Periods/week			Credit	Maximum Marks		
MEUC119	Machining Processes	L	T	P	C	CA	SE	TM
		3	-	-	3	40	60	100
Prerequisite	-							
Course Outcome  At the end of the course students will be able to	CO1	define the mechanics of metal cutting of machine tools						
	CO2	learn safe machining practices, machine tool mechanisms, basic operations and cutting parameters of various single point cutting tool machines						
	CO3	understand safe machining practices to economically produce precise & complex shapes on work pieces with special purpose machines.						
	CO4	have a comprehensive understanding of the principles, operation, and handling of drilling and boring machines						
	CO5	gain knowledge on non-traditional machining methods for machining complex shapes on difficult to machine materials with relatively less energy						
UNIT-I	Periods: 9							
Introduction to machining, nomenclature and tool geometry of single point cutting tool, tool materials & properties: classification, HSS, carbide tool, coated tools and inserts. Theory of Metal Cutting: Introduction. Orthogonal and oblique cutting. Mechanics of Metal Cutting, Chip formation, cutting force calculations, cutting fluids, cutting speed, feed and depth of cut on power requirement, Estimation of tool life.							CO1	
UNIT-II	Periods: 9							
<b>Lathe:</b> Types. Introduction to Capstan, Turret Lathe and Automates, mechanism and attachments for various operations, machine specifications, basis for selection of cutting speed, feed and depth of cut, time estimation for turning operations such as facing, step turning, taper turning, threading, knurling. Simple calculations. <b>Shaper:</b> Types, specification, cutting parameters. Mechanism of shaper: Quick return mechanism, Crank & slotted link mechanism, Table feed mechanism, attachments for shaper, work holding devices, shaper operations. <b>Planer:</b> Introduction, specifications, description, types of planner, cutting parameters and basic operations							CO1, CO2	
UNIT-III	Periods: 9							
<b>Milling:</b> Introduction. Specification, types, column & knee type milling machine, fixed bed type milling machines, production milling machines, special purpose milling machines such as thread milling Machines, profile milling machine, Gear Milling. Hobbing machines. Mechanisms & Attachments for Milling, Cutting parameters, Types of milling operations, Types of milling cutters, Tool geometry & their specifications. Indexing - simple, compound and differential. <b>Slotter:</b> Specifications, types of slotting machines -production slotter, puncher slotter, tool room slotter, slotter tools.							CO1, CO3	
UNIT-IV	Periods: 9							
<b>Drilling:</b> Tools for drilling, classification of drills, twist drills, drill size and specifications, type of drilling machines-portable drilling machine. Bench drilling machine, radial drilling machine, universal drilling machine. Drilling machines operations, time estimation for drilling. <b>Reaming:</b> Introduction, description of reamer, type of reaming operations. <b>Boring:</b> Introduction, types of boring machine, horizontal boring machine, vertical boring machine, jig machine, micro boring and boring operations.							CO1, CO4	

UNIT-V	Periods: 9		
Unconventional Machining Process – broad Classification, working principle and process capability study of: Laser Beam Machining, Electric Discharge Machining, Electrochemical Machining, Electrochemical Grinding, Ultrasonic Machining and Abrasive Jet Machining.			CO5
Lecture Periods: 45	Tutorial Periods: -	Practical Periods: -	Total Periods: 45
Reference Books:			
1. P. N. Rao, Manufacturing Technology (Metal cutting & Machine tools) Vol. II, Tata Mc-Graw Hill,2018			
2. Hajra Chaudhary, Workshop Technology (Volume II), Media Promoters & Publishers,2018			
3. Rajput R.K., A Text Book of Manufacturing Technology, Laxmi Publications, New Delhi, 2nd edition, 2017.			
4. Shan H.S., Manufacturing Processes, Volume – I, 1st Edition, Pearson Education, New Delhi, 2012.			
5. S. Kalpakjian & S.R. Schmid, Manufacturing Engineering & Technology, VII edition, 2014			
6. Technology of Machine, Tata McGraw hill LLC, 9th edition 2024			
7. Production Technology, HMT, McGraw-Hill Education (India) Pvt Limited, 2001			
8. Roy A. Lindberg, Processes and Materials of Manufacture, Prentice Hall of India (p) Ltd, New Delhi, third edition, 2008.			
9. G Boothroyd, Fundamentals of Machining and Machine Tools, CRC Press, New Delhi, 3rd edition, 2005., 2005.			

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	2	2	-	-	-	-	-	-	-	-	1	1	2
<b>CO2</b>	2	3	-	-	-	-	-	-	-	-	1	1	2
<b>CO3</b>	2	2	-	-	-	-	-	-	-	-	1	1	2
<b>CO4</b>	2	2	-	-	-	-	-	-	-	-	1	1	2
<b>CO5</b>	3	3	-	-	-	1	-	-	-	-	1	1	2
<b>Mean</b>	<b>2.2</b>	<b>2.4</b>	-	-	-	<b>0.2</b>	-	-	-	-	<b>1</b>	<b>1</b>	<b>2</b>

Department : Mechanical Engineering			Programme : B.Tech (ME)						
Semester : Fifth			Course Category Code: PCC				Semester Exam Type: LB		
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUC120	Heat Transfer Laboratory		L	T	P	C	CA	SE	TM
			-	-	2	1	40	60	100
Prerequisite	-								
Course Outcome At the end of the course students will be able to	CO1	Analyse performance of machineries involving three different modes of heat transfer							
	CO2	Analyse performance of heat exchangers							
	CO3	Make use of thermodynamic property tables, heat transfer data, empirical equations to solve heat transfer problems							
1. Determination of thermal conductivity of composite slab 2. Determination of thermal conductivity of metal rod 3. Natural convection from a vertical cylinder 4. Natural convection from a horizontal cylinder 5. Pin fin apparatus 6. Determination of Emissivity of a Surface 7. Determination of Stefan Boltzmann Constant. 8. Determination of critical heat flux of boiling									CO1, CO3
9. Parallel flow and counter flow heat exchanger 10. Cooling tower.									CO1,CO2
Lecture Periods:-		Tutorial Periods:-		Practical Periods: 30			Total Periods: 30		
Reference Books:									
1. R.K Rajput, Heat and mass transfer, fifth revised edition 2012, Chand & Company Ltd. 2. R. C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, New Age Science, 2009 3. Yunus A. Cengel.Afshin J. Ghajar, Heat and mass transfer, McGraw –Hill Education , 2015 4. Incropera, F.P. and Dewitt, D. P., Fundamentals of Heat and Mass Transfer, IV Edition, John Wiley & Sons, 2000. 5. Bejan, A., Heat Transfer, John Wiley & Sons, 1993 6. Holman, J.P., Heat Transfer, X Edition, McGraw Hill Book Company, NY, 2009.									

### CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	3	-	-	-	-	-	1	-	-	-	2	1
<b>CO2</b>	3	-	1	1	-	-	-	1	-	-	-	2	1
<b>CO3</b>	3	1	-	-	-	-	-	-	-	-	-	2	1
<b>Mean</b>	<b>3</b>	<b>1.3</b>	<b>0.3</b>	<b>0.3</b>	-	-	-	<b>0.7</b>	-	-	-	<b>2</b>	<b>1</b>

Department : Mechanical Engineering		Programme : B.Tech (ME)						
Semester : Fifth		Course Category Code: PCC				Semester Exam Type: LB		
Course Code	Course Name	Periods/week			Credit	Maximum Marks		
MEUC121	Machining Processes Laboratory	L	T	P	C	CA	SE	TM
		-	-	2	1	40	60	100
Prerequisite	Machining Processes Theory							
Course Outcome At the end of the course students will be able to	CO1	select machine tools and understand the use of each tool/apparatus and machine tools						
	CO2	demonstrate machining skills on conventional and state of the art machine tools for part production as per geometrical specifications						
	CO3	demonstrate safety rules in workplace						
	CO4	apply and work as an individual and in a team						
Machine shop 1. Study of tools, measuring instruments and Lathe Machines 2. Plain turning and Step turning 3. Taper turning and Knurling 4. Thread cutting						CO1, CO2, CO3, CO4		
Special Machines 5. Study of tools, work holding devices, Shaper and Milling machine Shaper 6. Cube Shaping 7. V-Cutting Milling 8. Spur Gear 9. Helical Gear Grinding 10. Tool and cutter grinder: Single point cutting tool Nomenclature								
CAM Lab 11. Part programming, Simulation and part production on CNC Lathe Trainer: Plain & Step turning, contouring and chamfering etc., 12. Part programming, Simulation and part production on CNC Mill Trainer: End Milling, Pocket Milling, etc., 13. 3D Printing: Demonstration (Production of simple jobs)								
Lecture Periods: -		Tutorial Periods: -		Lecture Periods: 30		Tutorial Periods: 30		
Reference Books: 1. S.K. Hajra Choudhury, Nirjhar Roy, Elements of Workshop Technology Volume 2 (Machine Tools) Revised and enlarged 15 <sup>th</sup> edition, 2023 2. P. N. Rao, Manufacturing Technology (Metal cutting & Machine tools) Vol. II 2019								

### CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	-	-	2	-	-	1		-	2	1	1
CO2	3	-	-	-	-	-	-	1		-	1	2	1
CO3	-	-	-	-	-	1	1	1		-	1	-	1
CO4	-	-	-	-	-	-	-	2		-	-	-	-
Mean	1.5	-	-	-	0.5	0.3	0.3	1.3		-	1	0.8	0.8

# **SEMESTER – VI**

Department : Mechanical Engineering		Programme : B.Tech (ME)						
Semester : Sixth		Course Category Code: PCC				Semester Exam Type: TY		
Course Code	Course Name	Periods/week		Credit		Maximum Marks		
MEUC122	Thermal Engineering-II	L	T	P	C	CA	SE	TM
		3	1	-	4	40	60	100
Prerequisite	-							
Course Outcome At the end of the course students will be able to	CO1	Explain the construction and working of refrigeration, air-conditioning and air compressor systems						
	CO2	Apply the laws of thermodynamics and determine the performance of refrigeration, air-conditioning and air compressor systems						
	CO3	Illustrate the properties, applications and environmental issues of refrigerant						
	CO4	Make use of thermodynamic tables and charts for solving problems						
UNIT-I	Refrigeration Cycles and VCRS						Periods: 12	
Review of reversed Carnot engine and coefficient of performance –Types of refrigeration systems–Air refrigeration System-Unit of refrigeration Analysis of Vapour Compression Refrigeration System (VCRS): p-h and T-s charts. Effects of suction pressure, delivery pressure, sub-cooling and super heating of liquid on the performance of vapour compression refrigeration system. Actual vapour compression cycle. Solving problems using refrigerant tables and charts.							CO1, CO2, CO4	
UNIT-II	VARs, Refrigerants and Cryogenics						Periods: 12	
Simple and practical Vapour Absorption Refrigeration System (VARs) - Comparison between VCRS and VARs-COP. Refrigerants: Classification: Desirable properties of refrigerants – Primary and secondary refrigerants – Nomenclature-Selection of refrigerants- ODP & GWP. Introduction to Cryogenics (Theoretical treatment only): Liquefaction – Air liquefaction system- Simple Linde cycle-Claude cycle							CO1, CO3	
UNIT-III	Air-conditioning systems						Periods: 12	
Comfort air-conditioning – Factors governing human comfort – Comfort chart. Summer air-conditioning and winter air-conditioning systems. Central, zoned, unitary and Unitary-Central air-conditioning systems, Package units and central units, Air filters, Fans.							CO1, CO2, CO4	
UNIT-IV	Sources of heat gain						Periods: 12	
Conduction load – Sun load – Load from occupants – Equipment load – Infiltration air-load – Load from moisture gain – Fresh air load – ASHRAE standards –Room sensible heat factor-Grand sensible heat factor-Effective room sensible heat factor- Calculation of load on air-conditioning system							CO2, CO4	
UNIT-V	Reciprocating and rotary air compressors						Periods: 12	
Reciprocating air compressors- Classification and Applications-Single stage reciprocating air compressors-construction and Working-Theoretical and actual p-V Diagrams-Multistage Compressors-Calculation of work, free air delivered, power required and various efficiencies. Compressor performance Rotary compressors (Theoretical treatment only): Construction and working of Positive displacement and steady flow compressors- Applications-Blowers and fans							CO1, CO2	
Lecture Periods: 45		Tutorial Periods: 15		Practical Periods: -		Total Periods: 60		
Reference Books:								
1. Kothandaraman, C. P., and Domkundwar, A course in Thermal Engineering, Dhanpat Rai &								

Co, 2013

2. Sarkar, B.K., 'Thermal Engineering', Tata McGraw-Hill Publishers, 2007
3. R.K Rajput, 'Thermal Engineering', Laxmi Publications, Eleventh edition.
4. Rudramoorthy, R, 'Thermal Engineering', Tata McGraw-Hill, New Delhi, 2003
5. Ramalingam. K.K., 'Thermal Engineering', SCITECH Publications (India) Pvt. Ltd., 2009.
6. Arora, C. P., 'Refrigeration and Air conditioning', Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2000
7. Stoecker, W. F. and Jones, J. W., 'Refrigeration and Air conditioning', McGraw Hill Book Publishing Co. Ltd., New York, 1995
8. S. N. Sapali, 'Refrigeration and Air Conditioning', second Edition, PHI, May 2014

### **CO-PO MAPPING**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	-	-	-	-	1	1	-	-	-	-	1	1
CO2	3	2	1	-	-	-	-	-	-	-	-	2	1
CO3	2	-	-	-	-	1	-	-	-	-	-	-	-
CO4	3	2	2	-	-	-	-	-	-	-	-	1	1
Mean	2.5	1	0.8	-	-	0.5	0.3	-	-	-	-	1	0.8

Department : Mechanical Engineering			Programme : B.Tech (ME)						
Semester : Sixth			Course Category Code: PCC			Semester Exam Type: TY			
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUC123	Design of Machine Elements	L	T	P	C	CA	SE	TM	
		3	1	-	4	40	60	100	
Prerequisite	-								
Course Outcome  At the end of the course students will be able to	CO1	Analyze principal stresses in engineering components and apply failure theories to design welded joints under static and fluctuating loads.							
	CO2	Evaluate the strength and stability of power screws and bolted joints subjected to fluctuating loads, combined stresses, and eccentric loading.							
	CO3	Design and compare different types of couplings, clutches, and brakes for mechanical power transmission based on load and functional requirements.							
	CO4	Design helical and leaf springs considering fluctuating loads, and develop cotter, knuckle, and pipe joints for mechanical applications.							
	CO5	Apply fatigue failure theories (Soderberg, Goodman) to design shafts under combined stresses for finite and infinite life.							
UNIT-I	Introduction							Periods: 12	
Fundamentals of machine design - Design philosophy- Engineering Materials- Brief overview of design and Manufacturing – Principal Stresses -Failure Theories - Design of Welded Joints -Types – Strength – Eccentric Loaded welded joints – Welded joints subjected to fluctuating load.								CO1	
UNIT-II	Power screws and Threaded joints							Periods: 12	
Strength and Stability Criteria, Design of Power Screws. Threaded Joints – Bolted Joints under fluctuating load, Combined Stresses, and eccentric loading.								CO2	
UNIT-III	Couplings and Brakes							Periods: 12	
Design of Couplings – Design of Rigid and flange Couplings – Types of Clutches and Design of Clutches. Types of Brakes – Design of Brakes.								CO3	
UNIT-IV	Springs							Periods: 12	
Introduction to Design of Helical Springs-Design of Helical Springs for Variable Load- Design of Leaf Springs- Design of Pipe Joints – Cotter and Knuckle joints.								CO4	
UNIT-V	Shafts							Periods: 12	
Design of Shafts under static load: members subjected to Eccentric loading – stresses in curved beams. Design of Shafts under Fluctuating Load: Design for Finite and Infinite life – Soderberg and Goodman equations – combined stresses.								CO5	
Lecture Periods: 45		Tutorial Periods: 15		Practical Periods: -		Total Periods: 60			
Reference Books									
1. V.B.Bhandari -Design of Machine Elements, Tata McGraw Hill publishing Co., 2010.									
2. Sharma and Purohit, Design of Machine Elements, PHI, 2009.									
3. Ganesh Babu, K. and Srithar, K., Design of Machine Elements, McGraw Hill Education (India) Pvt. Ltd., Noida, 2010.									
4. T. Jagadeesha, Design of Machine Elements, Universities Press(India) Private limited, Hyderabad,2018									
5. J. Shigley, Mechanical Engineering Design, McGraw Hill International Edition, 2011.									
6. Sadhu Singh, Machine Design, III Edition, Khanna Publishers, 2015.									
7. Design Data Hand Book, PSG College of Technology, Coimbatore									

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	3	-	-	3	-	-	-	-	-	-	3	-
<b>CO2</b>	-	3	2	3	-	-	-	-	-	-	-	3	-
<b>CO3</b>	-	3	-	3	3	-	-	-	-	-	-	3	-
<b>CO4</b>	-	-	-	3	3	-	-	-	-	-	-	3	-
<b>CO5</b>	-	-	3	3	3	-	-	-	-	-	-	3	2
<b>Mean</b>	<b>0.6</b>	<b>1.8</b>	<b>1</b>	<b>2.4</b>	<b>2.4</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>3</b>	<b>0.4</b>

Department: Humanities & Social Sciences			Programme: B.Tech.						
Semester : Fifth			Course Category Code: AEC				Semester Exam Type: TY		
Course Code	Course Name		Periods/ Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
HSUA105	Industrial Economics and Management		2	-	-	2	40	60	100
Pre-requisite	-								
Course Outcome  At the end of the course students will be able to	CO1	Demonstrate economic theories, analytical techniques applied to variety of economic and financial management issues.							
	CO2	Implement various management techniques based on the needs							
	CO3	Apply financial planning to ascertain the financial position of a company.							
	CO4	Apply planning, project scheduling and financial analysis to project management problems.							
	CO5	Understand marketing concepts applied to real-world scenarios, and develop effective marketing strategies.							
UNIT-I	Micro and Macro Economics and its Applications						Periods:6		
Nature and Scope of Economic science – Micro Economics: Economic decisions and Technical decisions, Demand and Supply concepts, Market Equilibrium, Elasticity of Demand, Various concepts of Cost – Break Even Analysis – Market structure. Macro Economics: Measures of National Income – Inflation – Business Cycle.									CO1
UNIT-II	Management Techniques						Periods:6		
Introduction to Management – Functions of Management – F.W.Taylor’s Scientific Management – Henry Fayol’s Principles of Management. Forms of Business Organization, and Types of (Ownership) of a firm.									CO2
UNIT-III	Industrial Finance						Periods:6		
Need for Finance –Types of finance – Sources of finance. Final Accounts - Preparation of Trading, Profit and loss Account and Balance Sheet.									CO3
UNIT-IV	Production Management						Periods:6		
Types of Production system – Production Planning and control: Planning, Routing, Scheduling, Inspection and Dispatches. Concepts of Productivity – Measurement of Productivity.									CO4
UNIT-V	Marketing Management						Periods:6		
Core Concepts of Marketing – Marketing Vs Selling – Channels of Distribution – Promotion Vs. Advertising – Market Research Vs Marketing Research.									CO5
Lecture Periods: 30			Tutorial Periods: –		Practical Periods: –		Total Periods: 30		
Reference Books:									
1. Varshney Maheswari, Managerial Economics, S Chand & Co, New Delhi, 2011. 2. Dutt & Sundaram, Indian Economy, S Chand & Co, New Delhi, 2015. 3. Pandey I.M, Elements of Financial Management Wiley Eastern Ltd, New Delhi, 2015. 4. H.L. Ahuja, Macro Economics for Business and Management, S Chand & Company Ltd, 2011. 5. O.P Khanna, Industrial Engineering and Management, Dhanpat Rai and Sons, 2009. 6. Philip B Kotler, Marketing Management, Mac Millan, NewYork, 2011.									

### CO-PO Mapping

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PSO1</b>	<b>PSO2</b>
<b>CO1</b>	-	1	-	-	-	3	-	-	-	-	2	1	-
<b>CO2</b>	-		-	-	-	-	-	-	-	3	2	-	1
<b>CO3</b>	-	1	-	-	-	-	-	-	-	3	2	1	-
<b>CO4</b>	-	-	-	-	-	-	-	-	-	3	2	-	1
<b>CO5</b>	-	-	-	-	-	-	-	-	-	3	2	1	-
<b>Mean</b>	-	<b>0.4</b>	-	-	-	<b>0.6</b>	-	-	-	<b>2.4</b>	<b>2</b>	<b>0.6</b>	<b>0.4</b>

Department : Mechanical Engineering			Programme : B.Tech (ME)						
Semester : Sixth			Course Category Code: PCC			Semester Exam Type: LB			
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUC124	Thermal Engineering Laboratory	L	T	P	C	CA	SE	TM	
		-	-	2	1	40	60	100	
Prerequisite	-								
Course Outcome At the end of the course students will be able to	CO1	Make use of devices to measure load, fluid flow, temperature, pressure, power							
	CO2	Measure the properties of liquid fuels/lubricating oils							
	CO3	Analyse the performance of thermal systems ( internal combustion engines, refrigerator, air-conditioner, compressor and blowers )							
	CO4	Make use of thermodynamic charts to determine the performance of thermal system							
Properties of fuel/oil 1. Determination of flash and fire point of given fuel/oil using open cup/closed cup apparatus 2. Determination of calorific value of a given solid/liquid/gaseous fuel 3. Determination of viscosity of given fuel/oil using Redwood viscometer								CO1, CO2	
Performance of Internal combustion engines 4. Valve timing diagram 5. Load test on a single cylinder petrol engine 6. Load test on a single cylinder diesel engine 7. Load test on a multi-cylinder diesel engine 8. Heat balance test on a single cylinder diesel engine								CO1, CO3	
Performance of Refrigeration and air-conditioning systems 9. Performance test on a vapour compression refrigeration system 10. Performance test on an air-conditioning system								CO1, CO4, CO5	
Performance of air machines 11. Performance test on a reciprocating air compressor 12. Performance test on a centrifugal air blower								CO1, CO3	
Lecture Periods: -		Tutorial Periods: -		Practical Periods: 30			Total Periods: 30		
Reference Books: 1. Kothandaraman,C.P, Domkundwar, A course in Thermal Engineering, Dhanpat Rai & Co, 2013 2. R.K Rajput, Thermal Engineering, Laxmi Publications, Eleventh edition. 3. Arora, C. P., Refrigeration and Air conditioning, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2000 4. Manohar Prasad, Refrigeration and Air-conditioning Data Book, New Age International Publishers. 5. R.S Khurmi, J.K Gupta, Refrigeration Tables With Chart, S Chand Publishers, 2019									

### CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	-	-	-	3	1	-	1	-	-	1	2	-
<b>CO2</b>	1	-	-	-	2	1	-	1	-	-	1	1	-
<b>CO3</b>	3	2	-	-	-	-	-	1	-	-	1	2	1
<b>CO4</b>	3	2	-	-	2	-	-	-	-	-	-	2	2
<b>CO5</b>	2	1	-	-	2	1	-	1	-	-	1	2	1
<b>Mean</b>	<b>2.4</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>1.8</b>	<b>0.6</b>	<b>-</b>	<b>0.8</b>	<b>-</b>	<b>-</b>	<b>0.8</b>	<b>1.8</b>	<b>0.8</b>

Department : Mechanical Engineering			Programme : B.Tech (ME)						
Semester : Sixth			Course Category Code: PCC			Semester Exam Type: LB			
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUC125	Metrology and Measurements Laboratory	L	T	P	C	CA	SE	TM	
		-	-	2	1	40	60	100	
Prerequisite	Basic Mathematics: Basic Electrical and Electronics Concepts: Familiarity with circuits, sensors, and transducers. Introduction to Metrology: Basic concepts of measurement systems and instrumentation. Computer Basics: Data acquisition, analysis, and usage of digital tools for measurement. Mechanical Engineering Fundamentals: Concepts related to force, pressure, and material properties.								
Course Outcome  At the end of the course students will be able to	CO1	Perform calibration of various measurement devices and evaluate accuracy.							
	CO2	Apply metrological principles to measure mechanical and thermal parameters.							
	CO3	Analyze the working principles and applications of optical measurement techniques.							
	CO4	Implement strain measurement techniques and analyze stress-strain behavior.							
	CO5	Evaluate the accuracy and reliability of various measuring instruments through calibration.							
List of Experiments									
1. Calibration of Strain Gauge based on pressure transducer							CO1, CO2		
2. Calibration of LVDT for displacement measurement							CO1, CO4		
3. Calibration of resistance temperature detector							CO1,CO5		
4. External Taper angle measurement using Sin bar							CO1,CO3		
5. Calibration of Bourdon tube pressure gauge using dead weight pressure gauge tester							CO1,CO2, CO5		
6. Calibration of load cell							CO1,CO5		
7. Study of auto collimator							CO3		
8. Measurement of strain using cantilever beam strain measurement using trainee kit							CO1,CO4		
9. Measurement of small pressure difference using inclined tube manometer							CO1,CO2		
Lecture Periods:-		Tutorial Periods:-		Practical Periods: 30			Total Periods: 30		
Reference Books:									
1. R.K.Jain, Engineering Metrology, Khanna Publishers, Special edition, 2022									
2. N.V. Ragvendra and L. Krishnamurthy, Engineering Metrology and Measurements, Oxford publishers, 2013									
3. I.C.Gupta, A text book of Engineering Metrology, Dhanpat Rai Publications, 2019									

### CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	-	-	2	3	-	-	-	-	-	-	3	2
<b>CO2</b>	3	3	-	-	3	-	-	-	-	-	-	3	3
<b>CO3</b>	3	-	-	3	3	-	-	-	-	-	-	3	3
<b>CO4</b>	3	-	3	-	3	-	-	-	-	-	-	3	3
<b>CO5</b>	3	-	-	3	3	-	-	-	-	-	-	3	3
<b>Mean</b>	<b>3</b>	<b>0.6</b>	<b>0.6</b>	<b>1.6</b>	<b>3</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>3</b>	<b>2.8</b>

<b>Department : Mechanical Engineering</b>			<b>Programme: B.Tech (ME)</b>					
<b>Semester : Sixth</b>			<b>Course Category Code: PCC</b>			<b>Semester Exam Type: -</b>		
<b>Course Code</b>	<b>Course Name</b>	<b>Periods / Week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
		<b>L</b>	<b>T</b>	<b>P</b>		<b>C</b>	<b>CA</b>	<b>SE</b>
<b>MEUC126</b>	<b>Internship</b>	-	-	-	<b>2</b>	<b>100</b>	-	<b>100</b>
<b>Prerequisite:</b>	<b>-</b>							
<b>Course Outcome:</b> At the end of the course the student will be able to	<b>CO1</b>	Apply theoretical knowledge gained during coursework to real-world projects and tasks.						
	<b>CO2</b>	Develop soft skills such as communication, teamwork, problem-solving, and time management.						
	<b>CO3</b>	Demonstrate proficiency in relevant industry technologies or platforms.						
	<b>CO4</b>	Handle the demands and challenges of a professional setting						
The student is required to undergo ‘internship’ in industry / research laboratory / higher learning institution for a period of at least 4 weeks in a maximum of 2 spells during vacations. Each spell of internship shall be for a period of not less than 2 weeks. The main purpose of internship is to enhance the general professional outlook and capability of the student to advance his chances of improving the career opportunities. The student should get prior approval from the Head of the Department before undertaking the internship and submit a detailed report after completion for the purpose of assessment. A departmental committee shall evaluate the performance of the students.								CO1, CO2, CO3, CO4

### CO-PO Mapping

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PSO1</b>	<b>PSO2</b>
<b>CO1</b>	3	2	2	1	1	-	-	-	-	-	-	2	2
<b>CO2</b>	-	-	-	-	2	2	2	2	2	2	-	2	2
<b>CO3</b>	-	-	-	-	-	2		2	2	2	-	2	2
<b>CO4</b>	-	-	-	-	-	2	2	-	-	-	2	2	2
<b>Mean</b>	<b>0.8</b>	<b>0.5</b>	<b>0.5</b>	<b>0.3</b>	<b>0.3</b>	<b>1.5</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>0.5</b>	<b>2</b>	<b>2</b>

# **SEMESTER – VII**

<b>Department : Mechanical Engineering</b>		<b>Programme B.Tech (ME)</b>						
<b>Semester : Seventh</b>		<b>Course Category Code: PCC</b>				<b>Semester Exam Type: TY</b>		
<b>Course Code</b>	<b>Course Name</b>	<b>Periods/week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
<b>MEUC127</b>	<b>Automobile Engineering</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CA</b>	<b>SE</b>	<b>TM</b>
		<b>4</b>	<b>-</b>	<b>--</b>	<b>4</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>Prerequisite</b>	<b>-</b>							
<b>Course Outcome</b> At the end of the course students will be able to	<b>CO1</b>	Apply engineering analysis of an automobile and its sub-systems.						
	<b>CO2</b>	Apply engineering principles to automotive design.						
	<b>CO3</b>	Demonstrate with modelling and analysis methods.						
	<b>CO4</b>	Familiarization with the automotive industry and its terminology						
<b>UNIT-I</b>	<b>Engine Components</b>							<b>Periods: 12</b>
Engine cylinder, liners, piston, connecting rod, crankshaft, valves, valve actuating mechanisms, methods of swirl generation, choice of materials for different engine components, engine positioning, cooling requirements, methods of cooling, thermostat valves, different lubrication arrangements.								<b>CO1</b>
<b>UNIT-II</b>	<b>Ignition Systems</b>							<b>Periods: 12</b>
Fuel Injector - multi-point and single point fuel injection systems, fuel transfer pumps, fuel filters, fuel injection pumps and injectors. Battery Ignition systems, Magneto Ignition system, Transistor assist contacts. Electronic Ignition, Automatic Ignition advance systems.								<b>CO2, CO3</b>
<b>UNIT-III</b>	<b>Clutch and Gear Box</b>							<b>Periods : 12</b>
General arrangement of clutch, principle of friction clutches, constructional details, single plate and multi-plate. Gear box- synchromesh gear boxes, planetary gears, over drives, principle of automatic transmission, calculation of gear ratios, numerical calculations for torque transmission by clutches.								<b>CO2, CO3</b>
<b>UNIT-IV</b>	<b>Propeller and Differential</b>							<b>Periods : 12</b>
Propeller shaft and universal joints, differential, rear axle, steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, steering gears, power steering, general arrangements of links and stub axle, types of chassis frames.								<b>CO4</b>
<b>UNIT-V</b>	<b>Suspension, Brakes &amp; Steering Systems</b>							<b>Periods: 12</b>
Leaf spring, coil spring, independent suspension for front wheel and rear wheel. Air suspension system. Types of brakes, mechanical and hydraulic braking systems, brake shoe arrangements, disk brakes, drum brakes, Antilock –Braking systems, purpose and operation of antilock-braking system. Steering Components – Ackermann Jeantaud Steering linkage-Davis Steering gear, steering - wheel, column, shaft, gear, Power steering, Camber, Caster, Toe in & Toe out, Kingpin offset.								<b>CO2, CO4</b>
<b>Lecture Periods: 60</b>		<b>Tutorial Periods: -</b>		<b>Practical Periods: -</b>		<b>Total Periods: 60</b>		
<b>Reference Books:</b>								
1. William H Crouse & Donald L Anglin, Automotive mechanics, 10th Edition Tata McGraw Hill Publishing Company Ltd., 2007								
2. S. Srinivasan, Automotive Mechanics, 2nd Ed., Tata McGraw Hill 2003.								
3. Joseph Heitner, D Van Nostrand, Automotive mechanics: Principles and Practices- Company, Inc								
4. K. K. Ramalingam, Fundamentals of Automobile Engineering- Scitech Publications (India) Pvt. Ltd.								
5. R. B. Gupta, Satya Prakashan, Automobile Engineering- 4th edn.1984.								

6. Kirpal Singh, Automobile engineering-. Vol I and II 2002.

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	3	2	1	-	1	-	-	-	-	-	2	1
<b>CO2</b>	3	3	-	-	-	1	-	-	-	-	-	2	1
<b>CO3</b>	3	3	-	-	-	1	-	-	-	-	-	2	1
<b>CO4</b>	3	2	-	2	-	1	-	-	-	-	-	2	1
<b>CO5</b>	3	2	-	-	-	1	-	-	-	-	-	2	1
<b>Mean</b>	<b>3</b>	<b>2.6</b>	<b>0.2</b>	<b>0.6</b>	<b>-</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>2</b>	<b>1</b>

Department : Mechanical Engineering			Programme : B.Tech (ME)						
Semester : Seventh			Course Category Code: PCC			Semester Exam Type: TY			
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUC128	Computer Integrated Manufacturing	L	T	P	C	CA	SE	TM	
		3	1	-	4	40	60	100	
Prerequisite	-								
Course Outcome At the end of the course students will be able to	CO1	Apply the concept of computer integrated manufacturing and its implications.							
	CO2	Demonstrate the knowledge of robotic technology, kinematic analysis, Material Handling System and its applications.							
	CO3	Acquire insight on Flexible Manufacturing System, Implementation considerations, manufacturing system components.							
	CO4	Apply the knowledge of computer aided manufacturing and process planning.							
UNIT-I	Introduction to CIM						Periods: 12		
Introduction, Types of data, Types of interfaces, Computer network structures, computerized production management systems, Inventory management, MRP, Operation scheduling, Process monitoring, Computer aided quality control, Testing/ Inspection methods. 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 and matrices: production rate, production capacity, utilization and availability, manufacturing lead time, work-in- process, numerical problems.							CO1		
UNIT-II	Flexible Manufacturing System						Periods: 12		
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.							CO2, CO3		
UNIT-III	Computerized Manufacture Planning and Control System						Periods : 12		
Computer Aided Process Planning, Retrieval and Generative Systems, benefits of CAPP, Production Planning and Control Systems, typical activities of PPC System, computer integrated production management system, Material Requirement Planning, inputs to MRP system, working of MRP, outputs and benefits, Capacity Planning, Computer Aided Quality Control, Shop floor control.							CO2, CO3		
UNIT-IV	Computer Numerical Control and Robot Technology						Periods : 12		
Introduction, components of CNC, CNC programming, manual part programming, G Codes, M Codes, programming of simple components in turning, drilling and milling systems, programming with canned cycles. Cutter radius compensations. Robot anatomy, joints and links, common robot configurations, robot control systems, accuracy and repeatability, end effectors, sensors in robotics. Robot programming methods: on-line and off-line methods. Robot industrial applications: material handling, processing and assembly and inspection.							CO4		
UNIT-V	Additive Manufacturing Systems -Automated Factory						Periods: 12		
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. Recent trends in manufacturing, Hybrid manufacturing.							CO2, CO4		

Industry 4.0, functions, applications and benefits. Components of Industry 4.0, Internet of Things (IOT), IOT applications in manufacturing			
<b>Lecture Periods: 45</b>	<b>Tutorial Periods: -15</b>	<b>Practical Periods: -</b>	<b>Total Periods: 60</b>
<ol style="list-style-type: none"><li>1. Nanua Singh, Systems Approach to Computer Integrated Design and Manufacturing, John Wiley &amp; Sons,</li><li>2. Groover M.P, Automation, Production Systems and Computer Integrated Manufacturing, Prentice-Hall of India Pvt. Ltd., New Delhi, 2014</li><li>3. Burbidge, J.L. Group Technology in Engineering Industry, Mechanical Engineering pub. London</li><li>4. Ibrahim Zeid, CAD/CAM Theory and Practice, Tata McGraw Hill Publication</li><li>5. Jha N.K, Handbook of Flexible Manufacturing Systems, Academic Press Inc., 1991.</li><li>6. Askin, R.G. and Vakharia, A.J, Cleland, D.I. and Bidananda, B, Planning and Operation, in the automated factory - HandBook: Technology and Management” (Eds), TAB Books, NY, 1991.</li><li>7. Irani S.A, Cellular Manufacturing Systems, Hand Book</li><li>8. Kamrani, A.K, Parsaei, H.R and Liles, Planning, design and analysis of cellular manufacturing systems D.H. (Eds), Elsevier, 1995.</li><li>9. Gideon Halevi and Roland D. Weill , Principles of Process Planning, A logical approach, Chapman &amp; Hall, 1995.</li></ol>			

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	3	2	3	1	-	-	-	-	-	1	2	1
<b>CO2</b>	3	3	2	-	1	-	-	-	-	-	1	2	1
<b>CO3</b>	3	3	-	-	1	-	-	-	-	-	1	2	1
<b>CO4</b>	3	2	-	2	1	-	-	-	-	-	1	2	1
<b>Mean</b>	<b>3</b>	<b>2.8</b>	<b>1</b>	<b>1.2</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>2</b>	<b>1</b>

Department: Mechanical Engineering			Programme : B.Tech (ME)						
Semester : Seventh			Course Category Code: PCC			Semester Exam Type: TY			
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUC129	Industrial Engineering, Maintenance and Safety	L	T	P	C	CA	SE	TM	
		4	-	-	4	40	60	100	
Prerequisite	-								
Course Outcome At the end of the course students will be able to	CO1	Understand the principles of plant location and layout design for efficient operations.							
	CO2	Apply modern work study and material handling techniques to optimize production processes.							
	CO3	Understand the importance and need for maintenance engineering.							
	CO4	Analyse and implement safety in plant layout and industrial activities							
	CO5	Evaluate and manage modern engineering, preventive maintenance and safety evaluations for performance-driven management.							
UNIT-I	Plant Location and Layout						Periods: 12		
Selection of plant locations, territorial parameters, considerations of land, water, electricity, location for waste treatment and disposal, further expansions, safe location of chemical storages. Safe layout, equipment layout for process industries, engineering industry, construction sites, pharmaceuticals, fertilizers, refineries, food processing, nuclear power stations, thermal power stations. Industry 4.0 applications for smart plant layouts. Plant layout design -ergonomic principles.							CO1, CO5		
UNIT-II	Work Study						Periods: 12		
Study of operations – work content – work procedure – breakdown – human factors – safety and method study – methods and movements at the workplace – substitution with latest devices – robotic concepts – applications in hazardous workplaces – productivity, quality and safety (PQS).							CO2, CO3		
UNIT-III	Material Handling						Periods: 12		
Material Handling-Classification-safety consideration- manual and mechanical handling. Handling assessments and techniques- lifting, carrying, pulling, pushing, palletizing and stocking. Material Handling equipment-operation & maintenance. Maintenance of common elements-wire rope, chains slings, hooks, clamps. Hearing Conservation Program in Production industries							CO1 CO2 CO3		
UNIT-IV	Maintenance						Periods: 12		
Objectives of maintenance - types of maintenance – Breakdown, Preventive and Predictive maintenance. Predictive Maintenance - vibration analysis data and noise as maintenance tool –wear debris analysis - Condition monitoring concepts applied to industries –Diagnose faults – overhaul – testing and measurement using approved procedures - Total Productive Maintenance (TPM) -Economics of Maintenance-Computer aided maintenance – modern practice –modern manufacturing aspects.							CO2, CO4		
UNIT-V	Industrial Safety						Periods: 12		
Fundamentals of industrial safety, importance of safety in industry, causes of accidents and their preventive measures, safety policy, survey, inventory systems, safety committee and its activities, types of safety systems and equipment, safety terminology. Job safety analysis, job safety procedure, Hazop study, Fault tree analysis. Emergency planning and its objectives. Indian Boiler Act 1923, static and mobile pressure vessel rules (SMPV), motor vehicle rules, mines act 1952, workman compensation act, rules.							CO4, CO5		
Lecture Periods: 60		Tutorial Periods: -		Practical Periods: -		Total Periods: 60			

**Reference Books:**

1. O.P. Khanna, Industrial engineering and management,
2. Accident Prevention Manual for Industrial Operations, 3rd edition, N.S.C. Chicago, 2010(digital)
3. Heinrich H.W. Industrial Accident Prevention, 2nd edition, Tata McGraw-Hill Company, New York, 1941.
4. Krishnan N.V, Safety Management in Industry, 1st edition, Jaico Publishing House, Bombay, 1997.
5. John R Ridley, Safety at Work, 3rd edition, Elsevier, 2014
6. Roland P. Blake, Industrial Safety, 2<sup>nd</sup> edition, Prentice Hall, Inc., New Jersey, 1973
7. L.M Deshmukh, Industrial safety management, 1<sup>st</sup> edition, TATA McGraw Hill, 2005

**CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	1	-	-	-	2	-	1	1	-	-	3	2
CO2	3	2	-	-	-	2	-	1	1	-	-	3	3
CO3	3	3	-	-	-	2	-	1	1	-	-	3	3
CO4	3	1	-	-	-	2	-	1	1	-	3	3	3
CO5	3	2	-	-	-	2	-	3	3	-		3	3
Mean	3	1.8	-	-	-	2	-	1.4	1.4	-	0.6	3	2.8

Department : Mechanical Engineering			Programme : B.Tech (ME)					
Semester: Seventh			Course Code:		PCC	Semester Exam Type: LB		
Course Code:	Course Name:	Periods/Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
MEUC130	Modelling and Simulation Analysis Laboratory	-	-	2	1	40	60	100
Prerequisite	Basics of Solid Mechanics, Fluid Mechanics, HMT, and Numerical Methods							
Course Outcome At the end of the course students will be able to	CO1	Analyze force distributions under diverse loading conditions						
	CO2	Evaluate using finite element analysis (FEA) compliance with thermal management standards.						
	CO3	Investigate and synthesize failure mitigation strategies for real-world applications						
	CO4	Design models for industrial problems						
	CO5	Develop models for industrial applications						
List of Experiments								
1. Analysis of cantilever beam with point load 2. Analysis of cantilever beam with uniformly distributed load 3. Analysis of simply supported beam with point load 4. Analysis of simply supported beam with uniformly distributed load 5. Analysis of solid shaft with torsion load 6. Plane stress analysis on plate with central hole 7. Beam with couple/moment 8. SFD BMD beam line body1d element cantilever 9. 1D static analysis of truss								CO1
10. 1-d heat transfer analysis of a simple plate 11. Thermal analysis steady state thermal heat sink 12. Thermal analysis of heat pipe thermal stress & deformation								CO1, CO2 CO3
13. Joint contact connection, using contact tool 14. Plane stress- strain 2d element 15. Axis-symmetry analysis hydrostatic pressure 2d element  16. Fatigue analysis of bracket, fatigue failure								CO1, CO2, CO4, CO5
Lecture Periods: -		Tutorial Periods: -		Practical Periods: 30		Total Periods: 30		
References/Manual/Books/Software:								
1. ANSYS Software Manual. 2. ANSYS WORKBENCH TUTORIALS 3. Logan L. Daryl, A first course in the Finite Element Method, 5 <sup>th</sup> Edition, Cengage Learning India Pvt. Ltd., Delhi, 2012. 4. David V Hutton, Fundamentals of Finite Element Analysis, Mc Graw Hill Companies, 2003 5. Saeed Moaveni, Finite element method. Theory and analysis with ANSYS, Prentice Hall, Year: 1999								

**CO-PO Mapping:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	3	-	-	-	-	-	-	3	2
CO2	3	3	3	2	3	-	-	-	-	-	-	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	3	3
Mean	3	3	2.8	2.6	3	-	-	-	-	-	-	3	2.8

<b>Department : Mechanical Engineering</b>			<b>Programme : B.Tech (ME)</b>						
<b>Semester : Seventh</b>			<b>Course Category Code: PCC</b>				<b>Semester</b>	<b>Exam</b>	<b>Type:</b>
<b>Course Code</b>	<b>Course Name</b>	<b>Periods / Week</b>		<b>Credit</b>		<b>Maximum Marks</b>			
		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CA</b>	<b>SE</b>	<b>TM</b>	
<b>MEUC131</b>	<b>Mini Project</b>	-	-	4	2	100	-	100	
<b>Prerequisite:</b>									
<b>Course Outcome</b> At the end of the course students will be able to	<b>CO1</b>	carry out literature survey, understand state of art techniques.							
	<b>CO2</b>	identify and apply appropriate tools to solve a problem.							
	<b>CO3</b>	transform knowledge into a theoretical/experimental process.							
	<b>CO4</b>	prepare and present reports on the project work.							
	The objective of this course is to enable the students to carry out the mini-project in a group. The topic shall be chosen in consultation with the Faculty coordinators. Each group of students is expected to make a detailed review of the literature, formulate the problem, carry out the mini project and prepare a report on the work done. The mini project can be a small project work or it can be a part of the work planned for the main project. The students should present the results of the work in the review committee meetings. A departmental committee shall evaluate the performance of the students							CO1, CO2, CO3, CO4	
<b>Lecture Periods: -</b>		<b>Tutorial Periods: -</b>		<b>Practical Periods: 60</b>			<b>Total Periods: 60</b>		

### CO-PO Mapping:

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PSO1</b>	<b>PSO2</b>
<b>CO1</b>	3	3	3	3	3	1	1	1	-	3	1	3	3
<b>CO2</b>	3	3	3	3	3	1	1	1	-	-	1	3	3
<b>CO3</b>	3	3	3	3	3	1	1	1	-	-	-	3	3
<b>CO4</b>	-	-	-	-	-	-	-	-	3	-	3	3	3
<b>Mean</b>	<b>2.3</b>	<b>2.3</b>	<b>2.3</b>	<b>2.3</b>	<b>2.3</b>	<b>0.8</b>	<b>0.8</b>	<b>0.8</b>	<b>0.8</b>	<b>0.8</b>	<b>1.3</b>	<b>3</b>	<b>3</b>

<b>Department: Mechanical Engineering</b>			<b>Programme : B.Tech (ME)</b>					
<b>Semester : Seventh</b>			<b>Course Category Code: PCC</b>			<b>Semester Exam Type: LB</b>		
<b>Course Code</b>	<b>Course Name</b>	<b>Periods / Week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
		<b>L</b>	<b>T</b>	<b>P</b>		<b>CA</b>	<b>SE</b>	<b>TM</b>
<b>MEUC132</b>	<b>Comprehensive Viva</b>	-	-	2	1	100	-	100
<b>Prerequisite:</b>								
<b>Course Outcome</b> At the end of the course students will be able to	<b>CO1</b>	Demonstrate a broad understanding of the subject area						
	<b>CO2</b>	Demonstrate complex concepts in an easy-to-understand way, answering questions confidently.						
	<b>CO3</b>	Explain unexpected and challenging questions.						
	<b>CO4</b>	Explain thoughtfully to feedback, and participate actively in discussions.						
	Comprehensive viva is an oral examination conducted to evaluate the critical thinking, analytical abilities, and how well a student can discuss and apply concepts learned throughout their studies. A committee comprising of five faculty members will conduct the comprehensive viva examination and evaluate the students. Experts from the industry may also be included in this committee. The Head of the Department shall constitute this committee							CO1, CO2, CO3, CO4
<b>Lecture Periods: -</b>		<b>Tutorial Periods: -</b>		<b>Practical Periods: 30</b>			<b>Total Periods: 30</b>	

### **CO-PO Mapping:**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PSO1</b>	<b>PSO2</b>
<b>CO1</b>	3	3	2	-	-	-	-	3	3	-	3	3	3
<b>CO2</b>	3	3	2	-	-	-	-	3	3	-	3	-	-
<b>CO3</b>	-	-	-	-	-	-	-	3	3	-	3	-	-
<b>CO4</b>	-	-	-	-	-	-	-	3	3	-	3	-	-
<b>Mean</b>	<b>1.5</b>	<b>1.5</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>3</b>	<b>3</b>		<b>3</b>	<b>0.8</b>	<b>0.8</b>

# **SEMESTER – VIII**

Department: Mechanical Engineering		Programme : B.Tech (ME)						
Semester : Eighth		Course Category Code: PCC				Semester Exam Type: PR		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
MEUC133	Project Work	-	-	16	8	60	40	100
Prerequisite:	-							
Course Outcome At the end of the course students will be able to	CO1	Carry out literature survey, understand state of art techniques.						
	CO2	Apply appropriate tools to solve a problem.						
	CO3	Transform knowledge into an theoretical/experimental process.						
	CO4	Prepare and present reports on the project work.						
	In project work, a team of students would solve the problem taken up for study. Simulation studies and/or hardware development would be completed. Necessary inferences have to be drawn from the studies carried out and the same should be presented before the committee members. If the project involves intensive analytical procedure, the analysis has to be completed and suitable comparison to existing methodologies reported in literature should be done to validate the correctness as well as effectiveness of the work. Rigorous review by the committee will be carried out in the process to ascertain whether the work qualifies as a suitable project at the graduate level. Each team is expected to present their work at National/International conferences or at the students' technical symposiums. Team that has come out with novel contribution will be encouraged to publish their work in any referred journals.							
Lecture Periods: -		Tutorial Periods: -		Practical Periods: 240			Total Periods: 240	

### **CO-PO Mapping:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	3	3	3	3	1	1	1	-	3	1	3	3
<b>CO2</b>	3	3	3	3	3	1	1	1	-	-	1	3	3
<b>CO3</b>	3	3	3	3	3	1	1	1	-	-	-	3	3
<b>CO4</b>	-	-	-	-	-	-	-	-	3	-	3	3	3
<b>Mean</b>	<b>2.3</b>	<b>2.3</b>	<b>2.3</b>	<b>2.3</b>	<b>2.3</b>	<b>0.8</b>	<b>0.8</b>	<b>0.8</b>	<b>0.8</b>	<b>0.8</b>	<b>1.3</b>	<b>3</b>	<b>3</b>

# Professional Electives – I

Professional Elective	Course Code	Course	Semester
<b>Professional Elective - I</b>	MEUE101	Product Engineering and Design Thinking	<b>V</b>
	MEUE102	Power Plant Engineering	
	MEUE103	Operations Research	
	MEUE104	Computer Aided Design	

Department : Mechanical Engineering			Programme : B.Tech						
Semester : Fifth			Course Category Code: PEC			Semester Exam Type: TY			
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUE101	Product Engineering and Design Thinking	L	T	P	C	CA	SE	TM	
		3	1	-	4	40	60	100	
Prerequisite	-								
Course Outcome At the end of the course students will be able to	CO1	Adopt conventional tools and Techniques in product Engineering							
	CO2	Select and adopt effective procedures and steps for embodiment design of a product							
	CO3	Adopt digital technologies.							
	CO4	Consider ethical and environmental sustainability requirements.							
UNIT-I	Periods: 12								
Introduction to Product design, product engineering, and design thinking; Product Design Specification and Planning Definition and Importance, Product Lifecycle Management, Design Thinking for need identification and product specification- Design Thinking-purpose- Creating User-Centric Products - methods - Customer Needs Analysis, Feasibility Study, Product Specifications & Requirements Engineering								CO1, CO2 CO3	
UNIT-II	Periods: 12								
Concept Generation, evaluation, selection, and testing methods, Embodiment design, product architecture, configuration design- Eco-design, Industrial Design –Aesthetics-Ergonomics-Human Factors, Computer-Aided Design (CAD) – overview of modelling and software aspects.								CO1, CO2, CO3	
UNIT-III	Periods: 12								
Engineering Aspects of Product Development- Mechanical analysis - Material Selection & Manufacturing Processes, Structural & Thermal Analysis - overview of analysis software, Design for Manufacturing and Prototyping Engineering (Digital and Rapid)- Product Innovation in Design Thinking Paradigm, Prototyping Techniques- 3D Printing-CNC Machining -Virtual Prototyping, Design for Assembly (DFA), AI/ML Integration in Product Engineering								CO1, CO3	
UNIT-IV	Periods: 12								
Testing & Quality Assurance - Functional & Performance Testing- Safety Standards & Compliance- Environmental & Stress Testing- Prototyping & User Testing, Manufacturing & Production Engineering. Mass Production Strategies- Lean Manufacturing & Six Sigma-Supply Chain & Logistics in Manufacturing- Sustainable & Green Manufacturing								CO1, CO2, CO4	
UNIT-V	Periods: 12								
Product Deployment & Post-Launch Support- Product Marketing & Branding Strategies- Customer Support & Maintenance, Product Upgrades & Future Roadmap, End-of-Life (EOL) Strategies & Recycling. Emerging Trends in Product Engineering- Digital Twin & Industry 4.0- Additive Manufacturing. AI & Automation in Product Design								CO1, CO2, CO3, CO4	
Lecture Periods: 45	Tutorial Periods: 15		Practical Periods: Nil			Total Periods: 60			
Reference Books:									
1. Gerhard Pahl, W. Beitz , JörgFeldhusen, Karl-Heinrich Grote, “Engineering Design: A Systematic Approach’, Springer London Ltd,2006									

2. Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", Adams Media Publication, 2014
3. Ulrich, Karl T., Eppinger, Steve D., and Yang, Maria C., "Product Design and Development", 7th ed., McGraw-Hill Education, 2020
4. Pavan Soni "Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-solving", Portfolio publisher, 2020
5. Tim Brown, "Change by Design, Revised and Updated: How Design Thinking Transforms Organizations and Inspires Innovation", Harper Business Publisher, 2019.

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	1	1	1	-	-	-	-	-	-	-	2	1
<b>CO2</b>	3	1	1	-	-	-	-	-	-	-	-	2	1
<b>CO3</b>	3	1	-	-	-	-	-	-	-	-	-	2	1
<b>CO4</b>	3	1	-	-	-	-	-	-	-	-	-	2	1
<b>CO5</b>	3	2	2	1	-	-	-	-	-	1	-	2	1
<b>Mean</b>	<b>3</b>	<b>1.2</b>	<b>0.8</b>	<b>0.6</b>	-	-	-	-	-	<b>0.2</b>	-	<b>2</b>	<b>1</b>

<b>Department : Mechanical Engineering</b>		<b>Programme : B.Tech (ME)</b>						
<b>Semester : Fifth</b>		<b>Course Category Code: PEC</b>				<b>Semester Exam Type: TY</b>		
<b>Course Code</b>	<b>Course Name</b>	<b>Periods/week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
<b>MEUE102</b>	<b>Power Plant Engineering</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CA</b>	<b>SE</b>	<b>TM</b>
		<b>3</b>	<b>1</b>	<b>-</b>	<b>4</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>Prerequisite</b>	<b>-</b>							
<b>Course Outcome</b> At the end of the course students will be able to	<b>CO1</b>	Understand the components and layout of different power plants.						
	<b>CO2</b>	Understand the performance of different power plants.						
	<b>CO3</b>	Explain waste disposal options for coal and nuclear power plants						
	<b>CO4</b>	Understand the economics and environmental impact of power plants						
<b>UNIT-I</b>	<b>Coal Based Thermal Power Plants</b>							<b>Periods: 12</b>
Steam Power Plant: layout- Accessories: Feed water Pump, economiser, air-preheater, super-heater, steam separator, Separator drums, Feed water heaters. Fuel handling: layout of fuel handling equipment, Combustion equipment for steam boilers: Burners– Fluidised bed combustion. Air handling system: forced draught fans, primary and secondary air system for solid fuels. Ash handling equipment. Chimney draught- natural, forced and induced draughts. Indian Boiler Act								CO1 CO2, CO3
<b>UNIT-II</b>	<b>Diesel, Gas Turbine and Combined Cycle Power Plants</b>							<b>Periods: 12</b>
Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems Gas turbine plant-site selection-classification – layout-classification of gas turbines-fuels-constant pressure and constant volume combustion turbines-effect of operating variables on thermal efficiency.								CO1, CO2
<b>UNIT-III</b>	<b>Nuclear Power Plants</b>							<b>Periods : 12</b>
Nuclear Power Plant: General aspects of nuclear engineering- nuclear reactors-classification- PWR, BWR-Components of a nuclear power plant-- Nuclear fuels – coolants – moderators – radiation shield – Nuclear Power Plant Layout – Waste disposal-site selection-advantages and applications of nuclear power plants.								CO1, CO3
<b>UNIT-IV</b>	<b>Hydroelectric Power Plants</b>							<b>Periods : 12</b>
Hydro Electric Power Plants – Classification, Typical Layout and associated components including Turbines. Application-advantages and disadvantages- Site selection - Essential elements like catchment area, reservoir, dam, spill way etc., Classification of Hydro Electric Power Plant (Low, medium and high head). Hydrology-hydrologic cycle, measurement of run-off-hydrographs- flow duration curve-mass curve.								CO1
<b>UNIT-V</b>	<b>Energy, Economic and Environmental Issues of Power Plants:</b>							<b>Periods: 12</b>
Power Plant Economics and Tariffs: Load curve, load duration curve, different factors related to plants and consumers, Cost of electrical energy, depreciation, generation cost, effect of load factor on unit cost. Fixed and operating cost of different plants, role of load diversity in power system economy. Objectives and forms of Tariff: Causes and effects of low power factor, advantages of power factor improvement, different methods for power factor improvements.								CO4
<b>Lecture Periods: 45</b>		<b>Tutorial Periods: 15</b>		<b>Practical Periods: -</b>		<b>Total Periods: 60</b>		
<b>Reference Books:</b>								
1. Nag. P.K., Power Plant Engineering, Third Edition, Tata McGraw – Hill Publishing Company Ltd.,2008. 2. A Textbook of Power Plant Engineering by R.K. Rajput   1 January 2016								
2. El-Wakil. M.M., Power Plant Technology, Tata McGraw – Hill Publishing Company Ltd., 2010.								

3. Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, Power Plant Engineering, Second Edition, Standard Handbook of McGraw – Hill, 1998.
4. B. Vijaya Ramnath C. Elanchezhian, L. Saravanakumar, Power Plant Engineering, November 2019
5. Dipak Kumar Mandal, Somnath Chakrabarti, et al., Power Plant Engineering, as per AICTE: Theory and Practice, January 2019

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	1	-	-	-	2	-	-	-	1	-	2	1
CO2	3	1	-	-	-	1	-	-	-	1	-	2	1
CO3	3	1	-	-	-		-	-	-	1	-	2	1
CO4	3	1	-	1	-	1	-	-	-	-	-	2	1
Mean	3	1.0	-	0.2	-	1	-	-	-	0.8	-	2	1

<b>Department : Mechanical Engineering</b>		<b>Programme : B.Tech (ME)</b>						
<b>Semester : Fifth</b>		<b>Course Category Code: PEC</b>				<b>Semester Exam Type: TY</b>		
<b>Course Code</b>	<b>Course Name</b>	<b>Periods/week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
<b>MEUE103</b>	<b>Operations Research</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CA</b>	<b>SE</b>	<b>TM</b>
		<b>3</b>	<b>1</b>	<b>-</b>	<b>4</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>Prerequisite</b>	Basic Mathematics, Probability and Statistics, Analytical and Logical Reasoning.							
<b>Course Outcome</b> At the end of the course students will be able to	<b>CO1</b>	Develop models for optimizing the management and production systems from the verbal description of the real system.						
	<b>CO2</b>	Apply LPP techniques for optimization of production mix problem in industry.						
	<b>CO3</b>	Evaluate transportation, transshipment, assignment and travelling salesman and Queuing problem						
	<b>CO4</b>	Apply quantitative techniques in machine replacement, game theory, business decision making under conditions of certainty, risk and uncertainty						
	<b>CO5</b>	Demonstrate project management problem.						
<b>UNIT-I</b>	<b>Introduction to Operations Research</b>							<b>Periods: 12</b>
Operations Research- definition, objective, development, characteristics and scope, decision-making, scope of operations research in management - financial management, supply chain, and IT systems. Application of various OR techniques, Role of OR in Industry 4.0 and Smart Manufacturing, applications in real-world scenarios.								CO1, CO5
<b>UNIT-II</b>	<b>Inventory Control and Management</b>							<b>Periods: 12</b>
Inventory control - deterministic and probabilistic models. Deterministic models - Classical EOQ Model-uniform and non-uniform demand, probabilistic models - stochastic demand and service levels. Just-in-Time (JIT), ABC Analysis, inventory management in lean systems, applications in e-commerce and global supply chains. Modern project management tools, smart project management for Industry 4.0, minimal spanning tree, shortest route, and maximum flow problems with practical applications in manufacturing and IT project management.								CO1 CO2 CO5
<b>UNIT-III</b>	<b>Linear Programming and Optimization Techniques</b>							<b>Periods: 12</b>
Problem formulation, graphical solutions, Optimization techniques – canonical and standard forms, Simplex method, Big-M and Two-Phase methods. Duality in LP and sensitivity analysis - resource allocation. Integer programming, goal programming, and multi-objective optimization - applications in logistics, production planning, and supply chain management.								CO2, CO4
<b>UNIT-IV</b>	<b>Transportation, Network, Assignment &amp; Sequencing Models</b>							<b>Periods: 12</b>
Travelling salesman problem. Definition of the transportation model, matrix terminology, formulation and solution of transportation models, variants in transportation problems. Network Analysis-network models, network analysis - project scheduling through CPM and PERT, critical paths, and project durations. Assignment models- mathematical representation, Hungarian method. Sequencing models- assumptions, processing n Jobs through one machine and m machines, problems related to sequencing (Routing problems in networks), Minimal path problem.								CO1 CO3
<b>UNIT-V</b>	<b>Game &amp; Queuing Theory</b>							<b>Periods: 12</b>
Introduction - Minimax (Maximin) Criterion and Optimal Strategy, Saddle Point, Solution of Games with Pure Strategy -Games with Mixed Strategies - 2 x 2 Games Dominance, Principle- Solution by Graphical Method of m x 2 & 2 x n games.								CO1, CO2 CO5

Introduction -Terminology, Service Channel, Arrival Pattern, Population, Departure Pattern(Service Pattern), Queue Discipline, Birth & Death Process, Balking, Reneging, Jockeying; Single Channel Models with Poisson Arrivals, Exponential Service Times with finite queue length and non-finite queue length.				
<b>Lecture Periods: 45</b>	<b>Tutorial Periods: -15</b>	<b>Practical Periods: -</b>	<b>Total Periods: 60</b>	
<b>Reference Books:</b>				
1. Kanti Swarup, Operations Research, 12th edition, Sultan Chand and Sons, New Delhi, 2010.				
2. Viswanathan N and Narahari Y, Performance Modeling of Automated Manufacturing Systems,2 <sup>nd</sup> edition, Prentice Hall of India, New Delhi, 2005				
3. Prem kumar Gupta and Hira D.S, Operation Research, 1st edition, S Chand and Company Limited, New Delhi, 2017				
4. Operations Research by R. Paneerselvam, Prentice Hall of India Pvt. Ltd, 2010				
5. Quantitative Techniques in Management by N D Vohra, Tata McGraw-Hill, 2013				
6. Operations Research by A M Natarajan, P Balasubramani, A Tamilarasi, Pearson Education Inc, 2009				

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	-	-	2	3	-	-	-	-	-	-	3	2
<b>CO2</b>	2	3	3	-	-	-	-	-	-	-	-	3	3
<b>CO3</b>	3	-	-	1	3	-	-	-	-	-	-	3	3
<b>CO4</b>	2	3	3	-	-	2	-	-	-	3	-	3	3
<b>CO5</b>	2	-	-	-	3		3	-	3	-	-	3	3
<b>Mean</b>	<b>2.4</b>	<b>1.2</b>	<b>1.2</b>	<b>0.6</b>	<b>1.8</b>	<b>0.4</b>	<b>0.6</b>	<b>-</b>	<b>0.6</b>	<b>0.6</b>	<b>-</b>	<b>3</b>	<b>2.8</b>

<b>Department : Mechanical Engineering</b>		<b>Programme : B.Tech</b>						
<b>Semester : Fifth</b>		<b>Course Category Code: PEC</b>				<b>Semester Exam Type: TY</b>		
<b>Course Code</b>	<b>Course Name</b>	<b>Periods/week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
<b>MEUE104</b>	<b>Computer Aided Design</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CA</b>	<b>SE</b>	<b>TM</b>
		<b>3</b>	<b>1</b>	<b>-</b>	<b>4</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>Prerequisite</b>	<b>-</b>							
<b>Course Outcome</b> At the end of the course students will be able to	<b>CO1</b>	Construct isometric drawings for simple engineering components.						
	<b>CO2</b>	Apply the fundamentals of parametric curves, surfaces and solids in real time applications.						
	<b>CO3</b>	Summarize the different types of Standard systems used in CAD.						
	<b>CO4</b>	Demonstrate the concepts of CAD in modern manufacturing industries.						
	<b>CO5</b>	Apply the role of graphics communication in the engineering design process.						
<b>UNIT-I</b>	<b>Introduction</b>							<b>Periods: 12</b>
Design process - Morphology of design, Types of design models, Application of design models, concurrent Engineering – CAD system architecture. CAD Hardware: workstation – CPU, mass storage, input devices (keyboard, light pen, thumb wheel joy stick, mouse, digitizer etc.,) and output devices (printers, plotters) Display Devices.								CO2, CO3, CO5
<b>UNIT-II</b>	<b>Transformation</b>							<b>Periods: 12</b>
Bresenham’s line and circle algorithms. Transformation in Graphics: co-ordinate system used in Graphics and windowing and view port transformations, Clipping, hidden line elimination, 2D transformations – rotation, scaling, translation, mirror, reflection and shear – homogeneous transformations concatenation, 3D Transformation – orthographic and Perspective Projections.								CO1, CO2, CO5
<b>UNIT-III</b>	<b>Geometric Modelling</b>							<b>Periods: 12</b>
Classification of Geometric Modelling – Wire frame, Surface and Solid Modelling, applications – representation of curves and surfaces – Parametric form – Design of curved shapes- Cubic spline – Bezier curve – B-spline – Design of Surfaces - features of Surface Modelling Package – Solid Primitives, CSG, Brep and description of other modelling techniques like Pure primitive instancing, cell decomposition, spatial occupancy enumeration, Boolean Operations (join, cut, intersection), Creating 3D objects from 2D profiles (extrusion, revolving etc.).								CO2, CO3, CO4
<b>UNIT-IV</b>	<b>Computer Graphics</b>							<b>Periods: 12</b>
Standards for computer graphics (GKS) and Data exchange standards – IGES, STEP. Data structures for Entity storage – Data structures for interactive modelling- Relational databases introduction to SQL language. Role of OOPS in CAD.								CO3, CO4
<b>UNIT-V</b>	<b>Expert Systems</b>							<b>Periods: 12</b>
Expert Systems –strategies for Knowledge Acquisition, representation of knowledge – Inference schemes. Parametric and variation modelling, Feature based modelling, Design information system an overview of modelling software like CREO, CATIA, SOLID WORKS, SOLID EDGE etc.								CO2, CO3, CO4
<b>Lecture Periods: 45</b>		<b>Tutorial Periods: 15</b>		<b>Practical Periods: -</b>		<b>Total Periods: 60</b>		
<b>Reference Books</b>								
1. Chris McMahon and Jimmie Browne - CAD/CAM – Principle Practice and Manufacturing Management, 2nd Edition, Addison Wesley England, 2000.								
2. Sadhu Singh - Computer Aided Design and Manufacturing, II Edition, Khanna Publishers, New Delhi, 2014								
3. P. Radhakrishnan et al - CAD/CAM/CIM, New Age International P Ltd., New Delhi, 2012.								

4. M.P. Groover and E.W. Zimmers - CAD/CAM; Computer Aided Design and Manufacturing, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2010.
5. Ibrahim Zeid - CAD/CAM Theory and Practice, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2013
6. P.N.Rao – CAD/CAM: Principles and Applications , McGraw Hill Education; 3rd edition, Noida, 2017

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	3	-	-	3	2
CO2	3	3	-	-	3	-	-	-	-	-	-	2	-
CO3	3	-	-	-	3	-	-	-	3	-	-	1	-
CO4	3	-	-	-	3	-	-	3	-	-	-	2	2
CO5	3	-	-	-	-	-	-	3	3	-	-	2	2
Mean	3	1.2	-	-	1.8	-	-	1.2	1.8	-	-	2	1.2

# Professional Electives – II

Professional Elective	Course Code	Course	Semester
<b>Professional Elective - II</b>	MEUE105	Solar Energy Engineering	<b>VI</b>
	MEUE106	Statistical Quality Control	
	MEUE107	Industrial Robotics	
	MEUE108	Fluid Power Automation	
	MEUE109	Finite Element Method	

<b>Department: Mechanical Engineering</b>		<b>Programme : B.Tech (ME)</b>						
<b>Semester : Sixth</b>		<b>Course Category Code: PEC</b>				<b>Semester Exam Type: TY</b>		
<b>Course Code</b>	<b>Course Name</b>	<b>Periods / Week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CA</b>	<b>SE</b>	<b>TM</b>
<b>MEUE105</b>	<b>Solar Energy Engineering</b>	<b>3</b>	<b>1</b>	<b>-</b>	<b>4</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>Prerequisite:</b>	-							
<b>Course Outcome</b> At the end of the course students will be able to	<b>CO1</b>	Analyse the techniques and methods involved in solar energy harvesting systems						
	<b>CO2</b>	Design and develop a prototype model of solar power system.						
	<b>CO3</b>	Synthesis a new option for a solar power system						
	<b>CO4</b>	Evaluate the performance characteristics of a solar direct power system						
	<b>CO5</b>	Analyse the suitability of application of solar system over conventional system						
<b>UNIT-I</b>	<b>Solar Radiation Geometry</b>						<b>Periods: 12</b>	
Solar energy utilization in India - solar spectrum, extra-terrestrial radiation, radiation on the earth surface - solar radiation geometry - solar radiation measurement– global, direct and diffuse solar radiation, solar radiation at a given location, annual variation in solar radiation, optimal tilt for solar equipment, monthly averaged global radiation at optimal tilt. – relationship among absorption and emittance and reflectance – selective surfaces.							CO1 CO3	
<b>UNIT-II</b>	<b>Solar Collector</b>						<b>Periods: 12</b>	
Flat Plate Collectors – collector efficiency – overall heat loss coefficient – performance of flat Plate collector. Tubular solar energy collectors - energy balance – thermal performance analysis – evacuated tube collector. Concentrating collectors -non imaging concentrators – linear imaging concentrators – paraboloid concentrators – central receiver collectors – thermal performance analysis – optical performance analysis - tracking mechanism for solar thermal collectors.							CO1 CO2 CO4	
<b>UNIT-III</b>	<b>Solar Thermal Devices</b>						<b>Periods: 12</b>	
Forced circulation systems – low flow pumped systems - natural circulation systems – integral collector storage systems. Solar cooling: absorption cooling, desiccant cooling, mechanical cooling – solar related air conditioning – passive cooling - combined solar heating and cooling. Direct and indirect solar cooking systems – solar food processing system – solar desalination, solar powered HDH system – solar PV/T system - solar furnace – solar chimney.							CO2, CO3	
<b>UNIT-IV</b>	<b>Solar Photovoltaic</b>						<b>Periods: 12</b>	
Photovoltaic Principle – materials for photovoltaic cells – efficiency of solar cell – solar cell materials - performance analysis of photovoltaic cells – Stationary and concentrated PV - Inverter and control technologies - Master slave inverter system design - Standalone systems - Grid connected systems - Hybridization, synchronization, and power evacuation - Recent developments in solar PV materials							CO1 CO4	
<b>UNIT-V</b>	<b>Solar Power Systems</b>						<b>Periods: 12</b>	
Solar power systems – electrical power generation – solar thermal power plants – low, medium and high temperature power generation systems– Site selection and land requirements - Techno-economic analysis of solar PV power plants - Environmental considerations-solar energy process economics. Legislations guiding solar energy sector - Critical review of various programs of government – State regulations - Jawaharlal Nehru National Solar Mission (JNNSM) - JNNSM Regulations regarding grid interconnected solar energy systems – Solar Energy policy – 2021.							CO2 CO3 CO4 CO5	
<b>Lecture Periods: 45</b>		<b>Tutorial Periods: 15</b>		<b>Practical Periods:-</b>			<b>Total Periods: 60</b>	

**Reference Books:**

1. S.P. Sukhatme, Solar Energy – Principles of Thermal Collection and storage, Tata McGraw Hill Publishing Co., New Delhi, 2008
2. JA Duffie and WA Beckman, Solar Engineering of Thermal Processes, John Wiley & Sons, 2006.
3. H.P. Garg and J. Prakash, Solar Energy, Tata McGraw – Hill Publishing Company Limited, 2007
4. G.D. Rai, Solar Energy Utilization, Khanna Publishers, 2005
5. Martin A. Green, Solar Cells – Operating Principles, Technology and System Applications, Prentice Hall Inc.
6. CS Solanki, “Solar Photovoltaics – Fundamentals, Technologies and Applications”, PHI Learning Pvt. Ltd., 2011.
7. Jayarama Reddy, “Solar Power Generation: Technology, New Concepts & Policy”, CRC Press, 2012.
8. VVN Kishore, “Renewable Energy Engineering and Technology – A Knowledge Compendium”, TERI Press, 2008.

**CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	-	2	-	3	-	-	-	-	-	-	-
CO2	3	3	-	2	3	-	-	-	-	-	-	-	-
CO3	3	-	-	2	3	3	-	-	-	-	-	-	-
CO4	3	-	-	3	3	-	-	-	-	-	-	-	-
CO5	3	-	-	3	-	3	-	-	-	-	-	3	-
Mean	3	1.2	-	2.4	1.8	1.8	-	-	-	-	-	0.6	-

Department : Mechanical Engineering			Programme : B.Tech (ME)						
Semester : Sixth			Course Category Code: PEC				Semester Exam Type: TY		
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUE106	Statistical Quality Control		L	T	P	C	CA	SE	TM
			3	1	0	4	40	60	100
Prerequisite	-								
Course Outcome  At the end of the course students will be able to	CO1	Develop control charts for attributes and variables to analyze the process quality							
	CO2	Demonstrate the quality assurance procedures							
	CO3	Describe the different sampling plans from acceptance sampling technique							
	CO4	Apply the process capability and statistical process control analysis for quality engineering							
UNIT-I	Periods: 12								
Importance of quality, Definition of quality, quality dimensions, quality planning, quality control, SQC, Quality assurance, quality costs, economics of quality, quality and Productivity and quality, quality loss function.								CO1	
UNIT-II	Periods: 12								
Process variation, – Statistical basis, 3 – sigma control limits, Rational sub-grouping, X, R and S charts, Interpretation of charts, warning and modified control limits.								CO1, CO2	
UNIT-III	Periods: 12								
P, np, C, U and k charts, limitations of control charts – moving average and moving range charts - quality control in service sector.								CO1, CO2	
UNIT-IV	Periods: 12								
Need for acceptance sampling, economics of sampling, sample selection, single and Double sampling – O.C. curves, Average outgoing quality (AOQ), Average sample Number (ASN), Average total inspection (ATI), Multiple and sequential sampling, sampling plans.								CO2, CO3	
UNIT-V	Periods: 12								
Process Capability Analysis, Process capability indices-Machine capability- Statistical Process control – Different SPC tools- Introduction to ISO 9000, ISO 14000 and QS 9000								CO3, CO4	
Lecture Periods: 45		Tutorial Periods: 15			Practical Periods: -		Total Periods: 60		
Reference Books:									
1. Statistical Quality Control, Eugene L. Grant and Richard S. Leaven Worth, TMH, Seventh Edition, 2012									
2. Quality Control. Dale H. Besterfield, Pearson Education Asia, Seventh Edition, 2012.									
3. Statistical Quality Control, M. Mahajan, Dhanpat Rai & co (P) Ltd									
4. Statistical quality control and Quality Management, R.C. Gupta, Khanna Publishers, 2010									
5. Introduction to Statistical Quality Control, Douglas C. Montgomery, John Wiley & Sons, 2013.									
6. Quality Control. Dale H. Besterfield, Pearson Education Asia, Seventh Edition, 2012.									

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	-	2	-	2	-	-	-	1	1
CO2	3	3	-	-	-	2	-	-	-	-	-	1	1
CO3	3	3	-	-	-	2	-	-	-	-	-	1	1
CO4	3	3	-	-	-	2	-	-	-	-	-	1	1
Mean	3	2.8	-	-	-	2	-	0.5	-	-	-	1	1

<b>Department : Mechanical Engineering</b>		<b>Programme : B.Tech (ME)</b>						
<b>Semester: Sixth</b>		<b>Course Category Code: PEC</b>				<b>Semester Exam Type: TY</b>		
<b>Course Code</b>	<b>Course Name</b>	<b>Periods/week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
<b>MEUE107</b>	<b>Industrial Robotics</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CA</b>	<b>SE</b>	<b>TM</b>
		<b>3</b>	<b>1</b>	<b>-</b>	<b>4</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>Prerequisite</b>								
<b>Course Outcome</b> At the end of the course students will be able to	<b>CO1</b>	Learn the types of robots and its construction details						
	<b>CO2</b>	Define and design Manipulator Kinematics & dynamic models for different configurations of industrial robotics						
	<b>CO3</b>	Develop on-line & off-line programming codes for automated industrial robotic						
	<b>CO4</b>	Understand the applications of robotics in industrial environment						
	<b>CO5</b>	Study the socio-economic aspects of robotic technology and its future scope in terms of technological developments						
<b>UNIT-I</b>		<b>Periods: 12</b>						
<b>Introduction to industrial robotics:</b> Types of Robots, Classification of Robots, Configurations, Robot Anatomy, functional line diagram, degrees of freedom. Components, common types of arms, joints grippers, factors to be considered in the design of grippers. <b>Robot actuators and feedback components:</b> Actuators, Pneumatic, Hydraulic actuators, Electric & Stepper motors, comparison. Position sensors - potentiometers, resolvers, encoders - velocity sensors, Tactile sensors, Proximity sensors.						CO1		
<b>UNIT-II</b>		<b>Periods: 12</b>						
<b>Manipulator kinematics:</b> All pre-requisite topics for the study of Homogenous transformations as applicable to rotation and transition - D-H notation, Forward kinematics (3DOF) and inverse kinematics (2DOF), Simple exercise problems. <b>Manipulator dynamics and Trajectory planning:</b> Differential transformations, Jacobians, Lagrange - Euler formations. Trajectory Planning: Trajectory Planning and avoidance of obstacles path planning, skew motion, joint integrated motion - straight line motion.						CO1, CO2		
<b>UNIT-III</b>		<b>Periods: 12</b>						
<b>Introduction to Robotic Programming</b> –Types - On-line and off-line programming - Motion commands, end effectors and sensors commands - Robot Languages- Classifications, Structures- VAL language commands motion control, hand control, program control, pick and place applications, palletizing applications using VAL. Robot welding application using VAL program- WAIT, SIGNAL and DELAY command for communications using simple applications. VAL-II programming-basic commands, applications- Simple problem using conditional statements-Simple pick and place applications.						CO1, CO3		
<b>UNIT-IV</b>		<b>Periods: 12</b>						
<b>Industrial Applications of Robots:</b> Material transfer, general considerations in Robotic material handling, Load handling capacity. Machine loading / unloading, welding, assembly and spray painting operations - CNC machine tool loading, Robot centered cell.						CO1, CO4		
<b>UNIT-V</b>		<b>Periods: 12</b>						
<b>Future scope of Robotics:</b> Socio-Economic aspect of robotization. Economical aspects for robot design, Safety for robot and standards, Introduction to Artificial Intelligence, AI techniques, Need and application of AI, New trends & recent updates in robotics.						CO5		

<b>Lecture Periods: 45</b>	<b>Tutorial Periods:15</b>	<b>Practical Periods: -</b>	<b>Total Periods: 60</b>
<b>Reference Books:</b>			
1. K.S. Fu, R.C Gonzalez and C.S. Lee, Robotics- Control, Sensing, Vision and Intelligence, Tata McGraw-Hill Editions, 2008 2. John J.Craig, Introduction to Robotics, Mechanics and control, 3rd edition, Pearson education, 2005. 3. Mark W.Spong, M.Vidyasagar, Robot dynamics and control, Wiley India, 2009. 4. Yoram Koren, Robotics for Engineer, McGraw-Hill Book Co., 1992. 5. Howie Choset, Kevin M. Lynch, Seth Hutchinson, George A. Kantor, Wolfram Burgard, Lydia E. Kavraki and Sebastian Thrun, Principles of Robot Motion – Theory, Algorithms and Implementation, MIT Press, 2005. 6. Mikell P. Groover, Mitchell Weiss, Industrial robotics, technology, Programming and Applications, McGraw Hill International Editions, 1986. 7. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014) 8. Asitava Ghoshal, Robotics: Fundamental concepts and analysis, Oxford University Press 3. (2006). 9. S. B. Niku, Introduction to Robotics – Analysis, Contro, Applications, 3rd edition, John 8. Wiley & Sons Ltd., (2020)			

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	3	-	-	-	-	-	-	-	-	-	1	-
<b>CO2</b>	3	3	-	-	3	-	-	-	-	-	-	1	-
<b>CO3</b>	3	-	-	-	3	-	-	3	-	-	-	1	-
<b>CO4</b>	3	-	-	-	3	-	-	3	-	-	-	1	-
<b>CO5</b>	3	-	-	-	3	-	-	-	-	-	3	1	-
<b>Mean</b>	<b>3</b>	<b>1.2</b>	<b>-</b>	<b>-</b>	<b>2.4</b>	<b>-</b>	<b>-</b>	<b>1.2</b>	<b>-</b>	<b>-</b>	<b>0.6</b>	<b>1</b>	<b>-</b>

Department : Mechanical Engineering			Programme : B.Tech (ME)						
Semester : Sixth			Course Category Code: PEC			Semester Exam Type: TY			
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUE108	Fluid Power Automation	L	T	P	C	CA	SE	TM	
		3	1	-	4	40	60	100	
Prerequisite	-								
Course Outcome At the end of the course students will be able to	CO1	Understand the concepts of fluid power and pneumatic circuits for automation							
	CO2	Apply the concepts of fluid power for control systems							
	CO3	Comprehend the concepts of fluid power for design of actuating mechanism							
	CO4	Develop the concepts of pneumatic circuits for automation in mechanical devices							
	CO5	Evolve the concepts of combined fluid power and pneumatic circuits for automation in mechanical systems							
UNIT-I								Periods: 12	
Introduction to Fluid power - Advantages- Filters - Seals - Hydraulic pumps - Classification – selection factors - Hydraulic Actuators - Linear - Rotary fluid motors.							CO1		
UNIT-II								Periods: 12	
Pressure – Direction - Flow control valves, relief valves, non-return and safety valves - Accumulators - Linear circuits - Regenerative circuits- Intensifier circuits - metering - In our circuits.							CO2		
UNIT-III								Periods: 12	
Reciprocation operation of multi cylinder - Quick return - Sequencing - Accumulator circuits - Use of pressure switches & limit switches - Hydrostatic transmission circuits - Fluid power maintenance and safety.							CO3		
UNIT-IV								Periods: 12	
Basic principles of Pneumatics – Types of Compressors – Elements of Pneumatic systems – Filters, lubricator, Muffler – Types of directional control valve - Air motors - Air cylinder.							CO4		
UNIT-V								Periods: 12	
Basic Pneumatic circuits - Speed control - Sequencing of motion - Hydro pneumatic circuits – cascade methods - Automation and Principle of circuit design – PLC-SCADA-Pneumatic control applications in machine tool and other mechanical fields – Maintenance.							CO5		
Lecture Periods: 45	Tutorial Periods: 15		Practical Periods: -			Total Periods: 60			
Reference Books:									
1. Anthony Esposito – Fluid power with Application, IV Edition, Prentice Hall, 1980.									
2. S.R. Majumdar – Pneumatic systems – Principles and maintenance, Tata McGraw Hill Publishing Company Ltd, 1995.									
3. Dudley A. Pease – Basic Fluid power, II Edition, Prentice Hall, 1998									
4. John J. Pippinger and Andrew Parr – Hydraulic and Pneumatic, Jaico Publishing House, 1999									

**CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	2	-	1	-	-	-	-	-	-	-	1	1
<b>CO2</b>	3	2	-	1	-	-	-	-	-	-	-	1	1
<b>CO3</b>	3	2	-	1	-	-	-	-	-	-	-	1	1
<b>CO4</b>	3	2	-	1	-	-	-	-	-	-	-	1	1
<b>CO5</b>	3	2	-	1	-	-	-	-	-	-	-	1	1
<b>Mean</b>	<b>3</b>	<b>2</b>	-	<b>1</b>	-	-	-	-	-	-	-	<b>1</b>	<b>1</b>

<b>Department : Mechanical Engineering</b>			<b>Programme : B.Tech (ME)</b>					
<b>Semester : Sixth</b>			<b>Course category Code: PEC</b>			<b>Semester Exam Type: TY</b>		
<b>Course Code</b>	<b>Course Name</b>	<b>Periods/Week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CA</b>	<b>SE</b>	<b>TM</b>
<b>MEUE109</b>	<b>Finite Element Method</b>	<b>3</b>	<b>1</b>	<b>-</b>	<b>4</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>Prerequisite</b>	Basics of Solid Mechanics, Numerical Methods							
<b>Course Outcome</b> At the end of the course students will be able to	<b>CO1</b>	Apply numerical methods to demonstrate proficiency in numerical simulation techniques.						
	<b>CO2</b>	Analyze structural / thermal problems to solve real-world mechanical challenges.						
	<b>CO3</b>	Evaluate the effects of parameter variations on mechanical systems.						
	<b>CO4</b>	Design finite element models to study the behavioural changes and safety issues in industries .						
	<b>CO5</b>	Develop FEA for computation and numerical integration.						
<b>UNIT-I</b>							<b>Periods: 12</b>	
Fundamental of FEA - historical context, matrix methods, and applications. Basic Element Shapes – Discretization Process – Node Numbering Scheme – Interpolation – Weighted Residual Method – Ritz Techniques – Applications of FEA.							CO1	
<b>UNIT-II</b>							<b>Periods: 12</b>	
1D problems and trusses - Finite Element Modelling – Element Types – Linear Elements – Linear Element Shape Function – Finite Element Equation – Galerkin’s Method – Solid Mechanics – Heat Transfer – Beam Element - Applications of Plane Truss.							CO1, CO2	
<b>UNIT-III</b>							<b>Periods: 12</b>	
2D problems - plane stress/strain - Constant Strain Triangular – Finite Element Formulation – Shape Functions – Strain Displacement and Stress Strain Relationship Matrix – Plane Stress and Plane Strain – Temperature Effects.							CO1, CO2, CO3,	
<b>UNIT-IV</b>							<b>Periods: 12</b>	
Axisymmetric Formulation – Element Stiffness Matrix and Force Vector – Body Forces and Temperature Effects – Stress Calculations – Boundary Conditions – Applications to Cylinders under Internal or External Pressure.							CO1, CO2, CO4	
<b>UNIT-V</b>							<b>Periods: 12</b>	
Natural Co-ordinate Systems – Iso-parametric Elements – The Four Node Quadrilateral – Shape Functions – Element Stiffness - Matrix and Force Vector – Jacobian Matrix – Stress Calculations – Numerical Integration – Gauss Quadrature.							CO1, CO2, CO5	
<b>Lecture Periods: 45</b>		<b>Tutorial Periods:15</b>		<b>Practical Periods: -</b>		<b>Total Periods: 60</b>		
<b>Reference Books:</b>								
1. Logan L. Daryl, A first course in the Finite Element Method, 5th Edition, Cengage Learning India Pvt. Ltd., Delhi, 2012.								
2. David V Hutton, Fundamentals of Finite Element Analysis, Mc Graw Hill Companies, 2003								
3. Saeed Moaveni, Finite element method. Theory and analysis with ANSYS, Prentice Hall, Year: 1999								
4. Rao S. S., The Finite Element Method in Engineering, 5th Edition, Butterworth–Heinemann (An imprint of Elsevier), Elsevier India Pvt. Ltd., New Delhi, 2013.								
5. Reddy J. N., An Introduction to the Finite Element Method, International Edition, McGraw Hill, New Delhi, 2005.								

**CO-PO-PSO Mapping:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	-	3	-	-	-	-	3	-	-	3	2
CO2	3	3	-	3	3	-	-	-	-	-	-	3	3
CO3	-	3	3	3	-	2	-	-	-	-	-	3	3
CO4	-	-	3	3	3	-	-	-	-	-	-	3	3
CO5	-	-	-	3	3	-	-	-	3	-	-	3	3
Mean	1.2	1.8	1.2	3	1.8	0.4	-	-	1.2	-	-	3	2.8

# Professional Electives – III

Professional Elective	Course Code	Course	Semester
<b>Professional Elective - III</b>	MEUE110	Computational Fluid Dynamics	<b>VII</b>
	MEUE111	Total Quality Management	
	MEUE112	Design of Transmission Systems	
	MEUE113	Electric and Hybrid Automotive Vehicle Technology	

<b>Department: Mechanical Engineering</b>		<b>Programme: B.Tech (ME)</b>						
<b>Semester: Seventh</b>		<b>Course Category Code: PEC</b>				<b>Semester Exam Type: TY</b>		
<b>Course Code</b>	<b>Course Name</b>	<b>Periods / Week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
		<b>L</b>	<b>T</b>	<b>P</b>		<b>CA</b>	<b>SE</b>	<b>TM</b>
<b>MEUE110</b>	<b>Computational Fluid Dynamics</b>	<b>3</b>	<b>1</b>	<b>-</b>	<b>4</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>Prerequisite</b>	Engineering thermodynamics, Fluid Mechanics, HMT and PD Equations.							
<b>Course Outcome</b> At the end of the course students will be able to	<b>CO1</b>	Identify, solve engineering problems by computational fluid dynamics.						
	<b>CO2</b>	Understand the various discretization methods, solution procedures and turbulence modelling.						
	<b>CO3</b>	Understand basic properties of computational methods – accuracy, stability, consistency						
	<b>CO4</b>	Analyze and provide numerical solutions for industrial problems.						
	<b>CO5</b>	Apply different computing techniques to solve complex problem.						
<b>UNIT I</b>	<b>Introduction</b>					<b>Periods : 12</b>		
Basics of Computational Fluid Dynamics (CFD) – Navier-Stokes system of equations – boundary conditions- One dimensional computation: Finite difference methods (FDM) – Finite element method (FEM) – Finite volume method (FVM) Governing equations: Classification of partial differential equations (PDE)								CO1
<b>UNIT II</b>	<b>Finite Difference Method</b>					<b>Periods : 12</b>		
Finite difference methods – Derivation of Finite Difference equation – Simple method – General method Higher order derivatives – Multi Dimensional Finite Difference Formulas – Mixes derivatives – Solution methods–Incompressible viscous flows.								CO2
<b>UNIT III</b>	<b>Finite Element Method</b>					<b>Periods : 12</b>		
Finite element methods – Formulation – Finite element interpolation functions – Linear problems – Non-linear problems– Formulations of finite volume equations: Burgers’ equations								CO3
<b>UNIT IV</b>	<b>Grid generation</b>					<b>Periods : 12</b>		
Structured grid generation: Algebraic methods – PDE mapping methods – Surface grid generation – Multi block structured grid generation. Unstructured grid generation: Delaunay-Voronoi methods (DVM) – Advancing front methods (AFM) – Combined DVM and AFM								CO4
<b>UNIT V</b>	<b>Specialized Techniques</b>					<b>Periods : 12</b>		
Computing techniques: Domain decomposition methods – Multigrid methods – Parallel processing. Applications of CFD:								CO5
<b>Lecture Periods: 45</b>		<b>Tutorial Periods: -15</b>		<b>Practical Periods: -</b>		<b>Total Periods: 60</b>		
<b>Reference Books:</b>								
1. Versteeg H.K and Malalasekera.W, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2nd edition, Pearson education, 2008								
2. Muralidhar K and Sundarajan T, Computational Fluid Flow and Heat Transfer, 2nd edition, Narosa publication, 2014								
3. Fletcher C.A.J., Computational Technique for Fluid Dynamics, Vol I & Vol II., springer-vorlag. berlin-2012.								

**CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	2	-	1	-	-	-	-	-	-	-	1	1
<b>CO2</b>	3	2	-	1	-	-	-	-	-	-	-	1	1
<b>CO3</b>	3	2	-	1	-	-	-	-	-	-	-	1	1
<b>CO4</b>	3	2	-	1	-	-	-	-	-	-	-	1	1
<b>CO5</b>	3	1	-	1	-	-	-	-	-	-	-	1	1
<b>Mean</b>	<b>3</b>	<b>1.8</b>	<b>-</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>1</b>

<b>Department : Mechanical Engineering</b>		<b>Programme : B.Tech (ME)</b>						
<b>Semester : Seventh</b>		<b>Course Category Code: PEC</b>				<b>Semester Exam Type: TY</b>		
<b>Course Code</b>	<b>Course Name</b>	<b>Periods/week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
<b>MEUE111</b>	<b>Total Quality Management</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CA</b>	<b>SE</b>	<b>TM</b>
		<b>3</b>	<b>1</b>	<b>-</b>	<b>4</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>Prerequisite</b>	<b>-</b>							
<b>Course Outcome</b>  At the end of the course students will be able to	<b>CO1</b>	Understand the fundamental concepts of quality management in industry.						
	<b>CO2</b>	Apply TQM principles to enhance organizational effectiveness.						
	<b>CO3</b>	Analyze and manage quality-related systems for continuous improvement.						
	<b>CO4</b>	Utilize advanced quality tools and techniques to improve process efficiency.						
	<b>CO5</b>	Demonstrate the ability to implement quality assurance practices in real-world scenarios.						
<b>UNIT-I</b>	<b>Introduction to TQM</b>					<b>Periods: 12</b>		
Concept of quality, Evolution of quality, Need for quality, Dimensions of manufacturing and service quality, Basic concepts of TQM, Definition of TQM, TQM Framework, Barriers to TQM, Quality control, and Quality management						CO1, CO5		
<b>UNIT-II</b>	<b>TQM Principles</b>					<b>Periods: 12</b>		
TQM principles, Leadership, Strategic quality planning, Quality statements, Customer focus: Customer orientation, Customer satisfaction, Customer complaints, Customer retention, Employee involvement: Motivation, Empowerment, Teamwork, Recognition, Rewards, Performance appraisal, Continuous process improvement (PDSA cycle) (Updated), 5S, Kaizen (Updated), Supplier partnership, Partnering, Supplier selection, Supplier rating (Updated).						CO2, CO3		
<b>UNIT-III</b>	<b>Science of Quality and Quality Information Systems</b>					<b>Periods: 12</b>		
Science of quality, Human resources and quality, Quality organization and management, Quality manual, Quality cost, Quality-related tasks, Quality Information System (QIS): Planning, Hardware, and Software systems (Updated).						CO3, CO4		
<b>UNIT-IV</b>	<b>Quality Tools and Techniques</b>					<b>Periods: 12</b>		
Seven traditional tools of quality, New management tools, Six Sigma: Concepts, Methodology, Applications in manufacturing and service sectors (including IT) (Updated), Benchmarking: Purpose and process (Updated), Failure Mode and Effects Analysis (FMEA): Stages and Types (Updated), Quality Circles, Quality Function Deployment (QFD), Taguchi's quality loss function (Updated).						CO4, CO5		
<b>UNIT-V</b>	<b>Quality Assurance and Statistical Process Control</b>					<b>Periods: 12</b>		
Statistical Process Control (SPC) (Updated), Quality deployment techniques, Quality control through measurement and counting, Quality systems (ISO 9000 series) (Updated), Quality assurance, Quality audits (Updated), Quality training programs (Updated), New quality management approaches (Updated), Advanced quality tools.						CO5, CO1		
<b>Lecture Periods: 45</b>		<b>Tutorial Periods: -15</b>		<b>Practical Periods: -</b>		<b>Total Periods: 60</b>		
<b>Reference Books:</b>								
1. Besterfield Dale H, Besterfield Carol, Besterfield Glen H, Besterfield Mary, Total Quality Management, 5 <sup>th</sup> Edition, Pearson education 2012.								
2. David L. Goetsch and Stanley Davis, Quality Management for Organizational Excellence.								
3. Eugene L. Grant and Richard S. Leavenworth , Statistical Quality Control.								
4. James R. Evans and William M. Lindsay, Managing for Quality and Performance Excellence.								

5. Douglas C. Montgomery, ISO 9001:2015 Quality Management Systems – Requirements (ISO Standard) Design and Analysis of Experiments.

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	-	-	2	1	-	-	-	-	-	-	3	2
<b>CO2</b>	-	3	3	-	-	-	-	-	-	-	-	3	3
<b>CO3</b>	3	-	-	3	3	-	-	-	-	-	-	3	3
<b>CO4</b>	-	-	3	-	-	1	-	-	-	3	-	3	3
<b>CO5</b>	-	-	-	-	3		3	3	-	-	-	3	3
<b>Mean</b>	<b>1.2</b>	<b>0.6</b>	<b>1.2</b>	<b>1</b>	<b>1.4</b>	<b>0.2</b>	<b>0.6</b>	<b>0.6</b>	<b>-</b>	<b>0.6</b>	<b>-</b>	<b>3</b>	<b>2.8</b>

Department : Mechanical Engineering			Programme : B.Tech						
Semester : Seventh			Course Category Code: PEC				Semester Exam Type: TY		
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUE112	Design of Transmission Systems	L	T	P	C	CA	SE	TM	
		3	1	-	4	40	60	100	
Prerequisite	-								
Course Outcome At the end of the course students will be able to	CO1	Calculate the parameters to design power transmission elements using standard catalogue.							
	CO2	Apply the concepts of design to belts, chains and bearings.							
	CO3	Apply the concepts of design to gear drives.							
	CO4	Apply the various design concepts on to real time product applications							
	CO5	Compute gear terminology considering strength and wear							
UNIT-I	Bearings							Periods: 12	
Theory of hydrodynamic bearing –design of journal bearing – heat dissipation – elementary ideas of hydrostatic bearings – bearing materials and lubricants. Rolling contact bearings – load capacity and life – selection of rolling contact bearings for radial and axial loads.								CO1, CO3, CO4	
UNIT-II	Belt drives and Chains							Periods: 12	
Belt drives – types – selection and design of flat and V-belts Chain drives – roller chains – polygonal effect – sprocket wheels – silent chain.								CO1, CO2	
UNIT-III	Spur and Helical Gear Drives							Periods: 12	
Advantage of gear drives over other drives, nomenclature, failures of gear tooth, design of spur gears & helical gears -based on bending and wears criteria – based on Lewis and Buckingham equation.								CO1, CO3, CO4, CO5	
UNIT-IV	Bevel and Worm Gear Drives							Periods: 12	
Bevel gears - nomenclature, design of gears – based on bending and wear criteria– based on Lewis and Buckingham equation, worm and worm wheel – nomenclature – design procedure.								CO1, CO3, CO4, CO5	
UNIT-V	Design of Gear Box							Periods: 12	
Geometric progression – standard step ratio – ray diagram, kinematics layout – design of sliding mesh gear box – constant mesh gear box – design of multi speed gear box. Introduction to gear design software – Gear generator, e-Machine shop Gear Design Software.								CO1, CO4, CO5	
Lecture Periods: 45		Tutorial Periods: 15		Practical Periods: -			Total Periods: 60		
Reference Books:									
1. T.J. Prabhu, Design of transmission elements, Madras book house, Chennai, 4th ed. 2000.									
2. T.J. Prabhu, Fundamentals of machine design, Scitech pub, 4th ed. 2000.									
3. T.Jagadeesha, Design of Machine Elements, Universities Press(India) Private limited, Hyderabad,2018									
4. J.E. Shigley, Mechanical engineering design, I metric edition, McGraw Hill International Edition, 2011.									
5. S.K. Basu, Design of machine tools, Oxford & IBH., 5 <sup>TH</sup> Edition 2008.									
6. Sadhu Singh, Machine design, Khanna Publishing House, 2015.									
7. R.B. Gupta, Auto Design, Satyaprakashan, 1990.									

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	-	2	3	-	-	-	2	-	-	3	-
CO2	2	3	-	3	3	-	-	-	-	-	-	3	-
CO3	3	3	2	3	3	-	-	-	2	-	-	3	-
CO4	2	3	-	3	3	-	-	-	3	-	-	3	-
CO5	-	3	3	3	3	-	-	-	2	-	-	3	2
Mean	2	3	1.4	2.8	3	-	-	-	1.8	-	-	3	0.4

Department : Mechanical Engineering			Programme : B.Tech						
Semester : Seventh			Course Category Code: PEC			Semester Exam Type: TY			
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUE113	Electric and Hybrid Automotive Vehicle Technology	L	T	P	C	CA	SE	TM	
		3	1	-	4	40	60	100	
Prerequisite	-								
Course Outcome  At the end of the course students will be able to	CO1	Know and adopt efficient techniques to store and utilize electrical energy for mobility							
	CO2	Consider Design aspects of EVs							
	CO3	Plan strategies to control EV mobility.							
	CO4	Able to implement Government regulations and policies, Safety standards of EVs.							
UNIT-I	Periods: 12								
Needs for Electric vehicles – History, Basics of Electric Vehicles , Components of Electric Vehicle, General Layout of EV, EV classification : Battery Electric Vehicles (BEVs), Hybrid Electric Vehicles (HEVs), Fuel-Cell Electric Vehicles (FCEVs) Main components and working principles of a hybrid Series HEVs, Parallel HEVs, Series–Parallel HEVs, Complex HEVs, Operating Modes, Degree of Hybridization, Comparison of HEVs, Plug-in Hybrid Electric Vehicles (PHEVs),Compare and contrast the performance of ICE vehicles, HEVs and EVs, Challenges in EV adoption. Overview of Tesla car.								CO1, CO2 CO3	
UNIT-II	Periods: 12								
Design requirements for electric vehicles- Basics of vehicle dynamics, power requirement, Tractive effort and vehicle performance. Aerodynamics and rolling resistance, Body and Chassis Fundamentals- Types of Structural System, Backbone Construction; Body and Chassis Materials. Power train Component sizing- Gears, Clutches, Differential, Transmission and Vehicle Brakes.								CO2, CO3	
UNIT-III	Periods: 12								
Motors and Drives, Introduction of DC-DC, AC-AC, AC-DC, DC-AC, four-quadrant operation, Driver circuits. Types of Motors- DC motors- AC motors, PMSM motors, BLDC motors, switched reluctance motors working principle, construction, efficiency and performance characteristics EV control system, Drivetrain architecture, types-motor controller- Battery management system-vehicle control unit, Control Strategies for Hybrid Vehicle.								CO1, CO3, CO4	
UNIT-IV	Periods: 12								
Energy Sources, Battery Parameters – Different types of batteries – Lead Acid- Nickel Metal Hydride – Lithium Ion-Sodium based- Metal Air., Battery Parameters-Battery Capacity-Discharge Rate-Charging Rate- SOC, SOD, SOH, DOD, Thermodynamic Voltage, Specific Energy, Specific Power, and Energy Efficiency. Battery management system. Battery recycling and sustainability Alternative energy storage systems, Introduction to fuel cell – Types, Operation and characteristics- proton exchange membrane (PEM) fuel cell for E-mobility– hydrogen storage systems- Graphene Battery –Super capacitors for transportation applications.								CO1, CO2	
UNIT-V	Periods: 12								
Electric vehicle charging infrastructure, Battery Charging Modes - Electric Vehicle Supply Equipment (EVSE) and its components – Classification of chargers based on								CO1, CO2,	

charging levels: AC Slow Charger, DC Fast Charger - AC-DC Converter and DC-DC Converter for EV Charger: Types and Working Principles . Government regulations and policies for EVs, Safety standards in EVS- ISO26262-ASIL			CO4
Lecture Periods: 45	Tutorial Periods: 15	Practical Periods: -	Total Periods: 60
<b>TEXT BOOKS:</b> 1. Iqbal Husain, “ Electric and Hybrid Vehicles-Design Fundamentals”, CRC Press,2011. 2. Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.			
<b>REFERENCE BOOKS:</b> 1. Seth Leitman and Bob Brant , “Build Your Own Electric Vehicle”, , McGraw Hill, Third Edition 2013. 2. Ali Emadi, Mehrdad Ehsani, John M.Miller, “Vehicular Electric Power Systems”, Special Indian Edition, Marcel dekker, Inc 2010. 3. Wie Liu, “Hybrid Electric Vehicle System Modeling and Control”,Second Edition, John Wiley & Sons, 2017.			

### CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	1	1	1	-	-	1	-	-	-	-	3
CO2	3	1	3	1	1	1	-	1	-	-	-	-	3
CO3	3	-	1	-	-	2	-	1	-	-	-	2	-
CO4	3	2	2	-	-	2	-	1	-	-	-	2	-
Mean	3	0.8	1.8	0.5	0.5	1	-	1	-	-	-	1	1.5

Annexure II	Syllabi of the <i>Ancillary Stream Elective Courses</i> offered by the Mechanical Engineering Department
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# Ancillary Stream Electives – I

Ancillary Stream Title	Course Code	Course	Semester
<b>Alternate Energy Sources (For all branches except Mechanical)</b>	MEUN101	Solar Energy	<b>IV, V, VI, VII</b>
	MEUN102	Wind, Wave and Tidal Energy	
	MEUN103	Bio-Energy	
	MEUN104	Hydrogen, OTEC and Geothermal Energy	

<b>Department : Mechanical Engineering</b>		<b>Programme : B. Tech.</b>						
<b>Semester : Fourth</b>		<b>Course Category Code: ANC</b>				<b>Semester Exam Type: TY</b>		
<b>Course Code</b>	<b>Course Name</b>	<b>Periods / Week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CA</b>	<b>SE</b>	<b>TM</b>
<b>MEUN101</b>	<b>Solar Energy</b>	<b>3</b>	<b>-</b>	<b>-</b>	<b>3</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>Prerequisite:</b>								
<b>Course Outcome</b> At the end of the course students will be able to	<b>CO1</b>	Analyse the techniques and methods involved in solar energy conversion systems						
	<b>CO2</b>	Design and develop a prototype model of solar power system.						
	<b>CO3</b>	Synthesis a new option for a solar power system						
	<b>CO4</b>	Evaluate the performance characteristics of a solar direct power system						
	<b>CO5</b>	Analyse the suitability of application of solar system over conventional system						
<b>UNIT-I</b>	<b>9</b>							<b>Periods:</b>
Introduction to solar energy – solar energy utilization in India - Solar radiation – measurement of solar radiation - solar radiation data geometry – solar radiation on horizontal and inclined surfaces – relationship among absorption and emittance and reflectance – Selective surfaces.								CO 1
<b>UNIT-II</b>	<b>9</b>							<b>Periods: 9</b>
Solar thermal devices: Flat plate collectors – materials for flat plate collector - collector efficiency – overall heat loss coefficient – performance of flat Plate collector. Concentrating collectors – improving efficiency of flat collector – cylindrical parabolic collector – compound parabolic collector – central receiver collector.								CO 2
<b>UNIT-III</b>	<b>9</b>							<b>Periods: 9</b>
Solar heating – air heating system – solar energy heat pump system – solar water heating system: forced and natural circulation system – passive solar heating system –Solar cooling –absorption cooling – solar dryers - solar pond – solar furnace								CO 3
<b>UNIT-IV</b>	<b>9</b>							<b>Periods: 9</b>
Photovoltaic Principle – materials for photovoltaic cells – efficiency of solar cell – solar cell materials - performance analysis of photovoltaic cells – Thermoelectric generator solar cell –photochemical solar cells – photovoltaic applications								CO 4
<b>UNIT-V</b>	<b>9</b>							<b>Periods: 9</b>
Solar power systems – electrical power generation – solar thermal power plants – low, medium and high temperature power generation systems: using flat plate collectors or solar ponds, concentrating collectors, central receiver and solar chimneys – solar energy process economics								CO 5
<b>Lecture Periods: 45</b>		<b>Tutorial Periods: -</b>		<b>Practical Periods: -</b>		<b>Total Periods: 45</b>		
<b>Reference Books:</b>								
1. S.P. Sukhatme, Solar Energy – Principles of Thermal Collection and storage, Tata McGraw Hill Publishing Co., New Delhi, 2008								
2. J.A. Duffie & W. Beckmann, Solar Thermal Processes, John Wiley, 1980.								
3. H.P. Garg and J. Prakash, Solar Energy, Tata McGraw – Hill Publishing Company Limited ,2007								
4. G.D. Rai, Solar Energy Utilization, Khanna Publishers, 2005								
5. Solar Cells – Operating Principles, Technology and System Applications /Martin A. Green/Prentice Hall Inc.								
6. John Twidell and Tony Weir, Renewable Energy Resources, Routledge; 2 Edition (24 November 2005)								

7. G.D. Rai Non-Conventional Energy Sources Published 2011 by Khanna Publishers
8. Dr. R.K. Singal, Non-conventional energy resources. S.K. Katara publication limited.

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	-	-	-	1	1	-	-	-	1	1	1
CO2	3	1	-	-	-	1	1	-	-	-	1	1	1
CO3	3	1	-	-	-	1	1	-	-	-	1	1	1
CO4	3	1	-	-	-	1	1	-	-	-	1	1	1
CO5	3	1	-	-	-	1	1	-	-	1	-	2	2
Mean	3	0.8	-	-	-	1	1	-	-	0.2	0.8	1.2	1.2

<b>Department : Mechanical Engineering</b>		<b>Programme : B.Tech</b>						
<b>Semester : Fifth</b>		<b>Course Category Code: ANC</b>				<b>Semester Exam Type: TY</b>		
<b>Course Code</b>	<b>Course Name</b>	<b>Periods/week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
<b>MEUN102</b>	<b>Wind, Wave and Tidal Energy</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CA</b>	<b>SE</b>	<b>TM</b>
		<b>3</b>	<b>-</b>	<b>-</b>	<b>3</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>Prerequisite</b>	<b>-</b>							
<b>Course Outcome</b>  At the end of the course students will be able to	<b>CO1</b>	Understand the wind, wave and tide characteristics and resource estimation.						
	<b>CO2</b>	Apply the phenomenology of fluid flows and the conservation laws To characterize a wind, wave and tidal machines .						
	<b>CO3</b>	Develop, design or select controls and machines for clean and environmental friendly energy generation.						
	<b>CO4</b>	Analyze and determine the forces exerted by the wind, wave and tides in static and in dynamic action.						
	<b>CO5</b>	Apply the type of wind, wave and tidal turbines used in power generation.						
<b>UNIT-I</b>	<b>Wind characteristics and Resources:</b>						<b>Periods: 9</b>	
Characteristics of wind: wind patterns, movement, profile, location and direction – estimation of wind power. Characteristics of atmospheric boundary layer-effect of terrain, roughness and obstacles. Wind data analysis, resource estimation and resource characterization.							CO1, CO4	
<b>UNIT-II</b>	<b>Aerodynamics and Controls</b>						<b>Periods: 9</b>	
Betz limit, Cut-in & Cut-out speeds, threshold wind speeds, wind power curve. Rotation principles: Drag & lift principle, thrust and torque estimation Effect of drag and blade numbers. Controls: Stalling and Pitch – breaking mechanism, electric and hydraulic pitching and yawing mechanism							CO1, CO2, CO3	
<b>UNIT-III</b>	<b>Classification, Site selection and Environment</b>						<b>Periods: 9</b>	
Types of wind turbines: horizontal and vertical axis, upwind and downwind, one, two and three blades, constant and variable speed, small and large wind turbines, wind farm. Site selection, wind measurement and instrumentation, installation and operation. Wind energy environmental aspects and impacts.							CO1, CO2, CO4	
<b>UNIT-IV</b>	<b>Wave Energy</b>						<b>Periods: 9</b>	
Fundamentals of wave mechanics, wave characteristics, generation, resources. Dynamics of waves, energy and power from waves. Wave energy conversion technologies-point absorbers, surface devices, underwater devices, overtopping devices, wave energy converter systems. Environmental impact and technology challenges.							CO1, CO4, CO5	
<b>UNIT-V</b>	<b>Tidal Energy</b>						<b>Periods: 9</b>	
Introduction-tidal current, high and low tides. Tidal power, average theoretical power per tide (rise and fall). Tidal energy conversion schemes - Single basin, Double basin and multi basin schemes. Tidal-dam-barrage-turbines, power plants. Tidal energy resources in India, environmental effects.							CO1, CO4, CO5	
<b>Lecture Periods: 45</b>		<b>Tutorial Periods:-</b>		<b>Practical Periods: -</b>		<b>Total Periods: 45</b>		
<b>Reference Books:</b>								
1. Earnest Joshua, Wind Power Technology, 9 <sup>th</sup> edition, PHI Learning, New Delhi, 2015								
2. Hau, Erich, Wind Turbines, 1 <sup>st</sup> edition, Springer-Verlag, Berlin Heidelberg, Germany, 2013.								
3. Earnest Joshua, Wind Power plants and Project developments, PHI Learning, New Delhi, 2015								
4. Gipe, Paul, Wind Energy Basics, Chelsea Green Publishing Co., New Delhi, 2009.								

5. Bhadra S. N, Kastha D., Banerjee S, Wind Electrical systems, Oxford University Press, New Delhi, 2013.
6. Siraj Ahmed, Wind Energy- Theory and Practices, 3<sup>rd</sup> Edition, PHI Learning, New Delhi, 2015
7. D. P. Kothari, K. C. Singal, Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies , , PHI Learning Private Limited, New Delhi
8. Paul Kruger, Alternative Energy Resources: The Quest for Sustainable Energy.
9. S.Hasan Saeed, Sharma, Non-conventional Energy Sources, D K. S.K. Kataria & Sons.

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	-	1	-	-	1	-	-	-	-	-	1	1
<b>CO2</b>	3	2	2	-	-	1	-	-	-	-	-	1	1
<b>CO3</b>	3	2	2	-	-	1	-	-	-	-	-	1	1
<b>CO4</b>	3	3	2	-	-	1	-	-	-	-	-	1	1
<b>CO5</b>	3	3	3	-	-	1	-	-	-	-	-	2	2
<b>Mean</b>	<b>3</b>	<b>2</b>	<b>2</b>	-	-	<b>1</b>	-	-	-	-	-	<b>1.2</b>	<b>1.2</b>

<b>Department : Mechanical Engineering</b>		<b>Programme : B.Tech</b>						
<b>Semester : Sixth</b>		<b>Course Category Code : ANC</b>				<b>Semester Exam Type : TY</b>		
<b>Course Code</b>	<b>Course Name</b>	<b>Periods/week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
<b>MEUN103</b>	<b>Bio-Energy</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CA</b>	<b>SE</b>	<b>TM</b>
		<b>3</b>	<b>-</b>	<b>-</b>	<b>3</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>Prerequisite</b>	<b>-</b>							
<b>Course Outcome</b> At the end of the course students will be able to	<b>CO1</b>	Classify the types and estimate the quantities of biomass available for energy usage.						
	<b>CO2</b>	Identify the properties of biomass relevant to energy/fuel conversion and their determination methods.						
	<b>CO3</b>	Explain the different methods of direct energy generation from biomass.						
	<b>CO4</b>	Explain the different types of biofuels synthesized from biomass.						
	<b>CO5</b>	Discover the economic and environmental benefits by the use of biomass.						
<b>UNIT-I</b>	<b>Periods: 9</b>							
Biomass, definition, classification – availability, estimation of availability – biomass resources – consumption and surplus biomass – energy plantations - briquetting – pelleting.							CO1, CO2	
<b>UNIT-II</b>	<b>Periods: 9</b>							
Biomass stoves, improved chullahs, types, some exotic designs – fixed bed combustors, types, inclined grate combustors – fluidized bed combustors – construction and working of all the above biomass combustors.							CO3	
<b>UNIT-III</b>	<b>Periods: 9</b>							
Biomass gasification, producer gas – fixed bed system, downdraft and updraft gasifiers – construction and operation – fluidized bed gasifiers – gasifier + burner arrangement for heating – gasifier + engine + genset arrangement for electricity							CO3	
<b>UNIT-IV</b>	<b>Periods: 9</b>							
Biomass pyrolysis, types – manufacture of charcoal, yields and application – manufacture of pyrolytic oils and gases, yields and applications. Torrefaction of biomass. Non-edible vegetable oils and its blends with diesel – esterification, methods, yields, catalysts – bio-diesel and its blends with diesel – use as engine fuel, performance of these fuels in engines, power output, efficiency and emissions.							CO4	
<b>UNIT-V</b>	<b>Periods: 9</b>							
Biological conversion of biomass, methods – methanol, ethanol production – fermentation – anaerobic digestion – biogas plants – types of digesters, some exotic designs, factors affecting biogas generation – biogas technology for cooling, lighting and shaft power production							CO3, CO4, CO5	
<b>Lecture Periods: 45</b>		<b>Tutorial Periods: -</b>		<b>Practical Periods: -</b>		<b>Total Periods: 45</b>		
<b>Reference Books:</b>								
1. Khandelwal, K. C. and Mahdi, S. S., Biogas Technology - A Practical Hand Book - Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.								
2. ABETS, Department of Aerospace Engineering, Biomass to Energy, Indian Institute of Science, Bangalore, 2003.								
3. Biomass – Thermo-chemical characterization, Indian Institute of Technology, Delhi, 1997.								
4. WereKo-Brobby, C. Y. and E. B. Hagan, Biomass Conversion and Technology, John Wiley &								

Sons,1996.

**CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	1	-	-	-	-	-	-	2	3
CO2	-	3	2	-	1	-	-	-	-	-	-	3	2
CO3	3	2	1	-	-	-	-	-	-	-	-	3	2
CO4	3	2	1	-	-	-	-	-	-	-	-	2	3
CO5	1	-	-	-	-	3	-	-	-	-	-	3	2
Mean	2	1.8	0.8	-	0.4	0.6	-	-	-	-	-	2.6	2.4

<b>Department : Mechanical Engineering</b>		<b>Programme : B.Tech</b>						
<b>Semester : Seventh</b>		<b>Course Category Code : ANC</b>				<b>Semester Exam Type : TY</b>		
<b>Course Code</b>	<b>Course Name</b>	<b>Periods/week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
<b>MEUN104</b>	<b>Hydrogen, OTEC and Geothermal Energy</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CA</b>	<b>SE</b>	<b>TM</b>
		<b>3</b>	<b>-</b>	<b>-</b>	<b>3</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>Prerequisite</b>	<b>-</b>							
<b>Course Outcome</b> At the end of the course students will be able to	<b>CO1</b>	Understand the nature and characteristics of hydrogen, ocean thermal and geothermal energy.						
	<b>CO2</b>	Apply different methods of production, storage, transportation and applications.						
	<b>CO3</b>	Apply the thermodynamic laws for the energy conversion.						
	<b>CO4</b>	Understand the safety measures and environmental aspects of handling these energy options.						
	<b>CO5</b>	Apply the usage of clean and sustainable energy systems.						
<b>UNIT-I</b>	<b>Hydrogen Generation</b>							<b>Periods: 9</b>
Properties of hydrogen – Production of hydrogen: natural resource – biological source - electrolytic process – thermal decomposition – biochemical method – photochemical method – photo-catalytic method.								CO1
<b>UNIT-II</b>	<b>Hydrogen Storage, Sensing &amp; Transportation</b>							<b>Periods: 9</b>
Modes of storage: gaseous, liquid – method of storage: compressed gas – liquid, metal hydrides, carbon nano-tubes– Hydrogen sensing and detection: hydrogen measuring principles, thermal conductivity, gas chromatography, mass spectroscopy, laser gas analysis. Transportation: compressed gas – cryo-cooled liquid systems.								CO2 CO3
<b>UNIT-III</b>	<b>Safety &amp; Standards</b>							<b>Periods: 9</b>
Hydrogen safety: hazards in hydrogen storage facilities – hazards in using hydrogen as fuel in transport sectors – hydrogen codes and standards: national codes – coordination of international and domestic standards.								CO2 CO3 CO5
<b>UNIT-IV</b>	<b>Ocean Thermal Energy</b>							<b>Periods: 9</b>
Introduction - principle of OTEC, Open cycle power plant - Claude Cycle, limitation of open cycle, modified open cycle OTEC plants, closed cycle power plant- Anderson Cycle, binary cycle power plant, cogeneration of electricity and fresh water, efficiencies of OTEC plants and hybrid power plants.								CO1 CO2 CO4 CO5
<b>UNIT-V</b>	<b>Geothermal Energy</b>							<b>Periods: 9</b>
Resources- Hydro geothermal - dry steam, wet steam -hot water, Geo pressure resources - hot dry rocks, magma resources, volcanoes. Merits and demerits of geothermal energy, Geothermal systems - Single flash steam plant, Double flash steam plant, Dry steam plants, Binary cycle power plants, Environmental effects.								CO1 CO2 CO4 CO5
<b>Lecture Periods: 45</b>		<b>Tutorial Periods: -</b>		<b>Practical Periods: -</b>		<b>Total Periods: 45</b>		
<b>Reference Books</b>								
1. Ram B. Gupta, Hydrogen Fuel: Production, Transport and Storage, CRC Press, 2009.								
2. Solanki, Chetan Singh., Renewable energy technologies : a practical guide for beginners, Prentice -Hall of India, 2008								
3. G.D. Rai, Non-Conventional Energy Sources, Khanna Publishers, 6 <sup>th</sup> Edition 2017.								
4. Prof. Sunil S. Rao and Dr. B.B. Parulekar, Energy Technology (Non-Conventional, Renewable								

and Conventional), Khanna Publishers, 3<sup>rd</sup> Edition 1994.

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	-	-	-	-	1	-	-	-	-	1	1
CO2	2	-	-	-	-	1	1	-	-	-	-	2	2
CO3	2	-	-	-	-	1	1	-	-	-	-	2	2
CO4	2	-	-	-	-	1	-	-	-	-	1	2	2
CO5	2	-	-	-	-	1	-	-	-	-	1	2	2
Mean	2.2	-	-	-	-	0.8	0.6	-	-	-	0.4	1.8	1.8

## Ancillary Stream Electives – II

Ancillary Stream Title	Course Code	Course	Semester
<b>Industrial Automation</b> (For all branches except Mechanical)	MEUN105	AI in Mechanical Engineering	<b>IV, V, VI, VII</b>
	MEUN106	Robotics and Automation	
	MEUN107	Sensors and Actuators	
	MEUN108	Smart Manufacturing	

Department : Mechanical Engineering			Programme : B.Tech						
Semester : Fourth			Course Category Code: ANC			Semester Exam Type: TY			
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUN105	AI in Mechanical Engineering	L	T	P	C	CA	SE	TM	
		3	-	-	3	40	60	100	
Prerequisite	-								
Course Outcome At the end of the course students will be able to	CO1	Apply the aspects of artificial intelligence in the context of manufacturing engineering.							
	CO2	Evaluate the different applications of deep learning methods.							
	CO3	Identify the various communication protocols, hardware and software, iot Layers and their relative importance							
	CO4	Apply the tools required for creating artificial intelligence applications in the manufacturing domain.							
UNIT-I	Artificial Intelligence (AI) concepts						Periods: 9		
Introduction to AI, problem formulation, problem definition, production systems, control strategies, search strategies, problem characteristics, production system characteristics, specialized production systems, problem solving methods, problem graphs, matching, indexing and heuristic functions, hill climbing, depth first and breath first, constraints satisfaction — Related algorithms, measure of performance and analysis of search algorithms							CO1		
UNIT-II	Deep Learning						Periods: 9		
Biological Motivation-Activation function-Cost function- Collaborative filtering-Vectorization-Back Propagation Algorithm with applications -Feed-Forward Neural Network Algorithm-Recurrent Neural Network Algorithm with applications - Convolutional Neural Network with applications							CO2, CO3		
UNIT-III	Expert Systems						Periods: 9		
Knowledge-based or expert systems: definition, structure, characterization and justification - Knowledge sources - Expert - Knowledge acquisition and representation - Knowledge base - Inference strategies: forward and backward chaining.							CO2, CO3		
UNIT-IV	Expert Systems Tools and Applications						Periods: 9		
Expert system shells: typical examples of shells - CLIPS programming - Expert system software for manufacturing applications in CAD, CAPP, MRP, adaptive control, robotics, process control, fault diagnosis, failure analysis, process selection. Material modelling and smart materials - Automobile engineering- building self-driving cars and autonomous vehicles. Auto parking - Machine learning in machine tools and manufacturing industries.							CO4		
UNIT-V	Artificial Neural Networks, Fuzzy Logic and Genetic Algorithms						Periods: 9		
Concepts of artificial neural networks, fuzzy logic and genetic algorithms - Manufacturing applications of neural networks, fuzzy logic and genetic algorithms - Case studies of typical applications in tool selection, process selection, part classification, inventory control, process planning, etc.							CO2, CO4		
Lecture Periods: 45		Tutorial Periods: -		Practical Periods: -		Total Periods: 45			

**Reference Books:**

1. Clocksin, W. F. and C. S. Mellish, Programming in PROLOG, Narosa Publishing House, New Delhi.
2. Giarratano, J. C. and G. D. Riley, Expert Systems - Principles and Programming, Cengage Learning, New Delhi.
3. Padhy, N. P., Artificial Intelligence and Intelligent Systems, Oxford University Press, New Delhi.
4. Rajasekaran, S. and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms, PHI Learning Private Limited, New Delhi
5. Donald.A.Waterman, A guide to expert systems, Addison Wesley publishing company , 1997
6. Kaushik Kumar, Divya Zindani, Paulo Davim, Artificial Intelligence in Mechanical and Industrial Engineering, ISBN 9781003011248, CRC Press, 2021.
7. Goodfellow, Bengio, Courville, Deep Learning, MIT Press, 2017.
8. Deepak Khemani , Artificial Intelligence, Tata Mc Graw Hill Education 2013

**CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	-	-	2		-	-	-	-	1	2	1
CO2	3	-	-	-	2		-	-	-	-	1	2	1
CO3	3	-	-	-		2	-	2	-	-	-	2	1
CO4	3	3	-	-	3		-		-	-	1	2	1
Mean	3	0.8	-	-	1.8	0.5	-	0.5	-	-	0.8	2	1

Department : Mechanical Engineering		Programme : B.Tech.						
Semester : Fifth		Course Category Code: ANC				Semester Exam Type: TY		
Course Code	Course Name	Periods/week			Credit	Maximum Marks		
MEUN106	Robotics and Automation	L	T	P	C	CA	SE	TM
		3	-	-	3	40	60	100
Prerequisite	-							
Course Outcome  At the end of the course students will be able to	CO1	Understand fundamental aspects of automation in industries.						
	CO2	Understand the basics of Numerical Control machines and part programming of Simple geometries.						
	CO3	Understand fundamental of automatic assembly line and production line.						
	CO4	Learn robot anatomy of robot, configuration of different robots, and Describe Construction and working of different types robots.						
	CO5	Represent Position and orientation of body, transformation of rigid body, Homogenous Transformation, The Manipulator Kinematics, D-H parameters, forward and inverse kinematics.						
UNIT-I	Introduction to Industrial Robots							Periods: 9
Robotics definition - robot configurations, robot anatomy, joint system, types of joints, work volume, robot drive systems, precision of movement, robotic sensors and actuators, end effectors, grippers, different types of grippers.								CO1
UNIT-II	Robot Actuators and Feed Back Components							Periods: 9
Actuators- pneumatic-hydraulic actuators, electric & stepper motors, comparison, position sensors – potentiometers- resolvers- encoders – velocity sensors-tactile sensors proximity sensors, robot applications in manufacturing.								CO2
UNIT-III	Manipulator Kinematics							Periods: 9
Representation of position and orientation of body, transformation of rigid body, homogenous transformation, the manipulator kinematics, d-h parameters, 2r and 3r mechanism d-h analysis, forward and inverse kinematics.								CO3
UNIT-IV	Numerical Control (NC)							Periods: 9
Introduction- NC procedure, NC coordinate systems, elements of NC systems, classification of NC systems, advantages and dis-advantages of NC systems, applications of NC, NC manual part programming, apt language.								CO4
UNIT-V	Manual Assembly Lines and Transfer Lines							Periods: 9
Fundamentals of manual assembly lines and automated production lines, alternative assembly systems, design for assembly, applications of automated production lines, analysis of transfer lines with no internal storage, analysis of transfer lines with storage buffers.								CO5
Lecture Periods: 45		Tutorial Periods: -		Practical Periods: -		Total Periods: 45		
Reference Books:								
1. K.S.Fu., R.C.Gonzalez, C.S.G. Lee, Robotics: Control Sensing, Vision and Intelligence, Indian Edition, McGraw Hill Book Co., 2008.								
2. Coiffet, P., & Chirouze, M., An introduction to robot technology, Springer Science & Business Media, 2012.								
3. Ghosal. A, Robotics: Fundamental concepts and analysis, Oxford university press, 2006 .								
4. Mittal R.K & Nagrath IJ, Robotics and Control, McGraw-Hill, 2017.								
5. Craig, John J, Introduction to Robotics, 2005.								

6. Mikell P. Groover, Automation, Production Systems and CIM, Prentice-Hall of India Pvt. Ltd, 2016.
7. Nicholas Odrey, Mitchell Weiss, Mikell Groover, Roger Nagel, Ashish Dutta, Industrial Robotics -Technology, Programming and Applications (SIE), McGraw-Hill 2nd Edition, 2017.
8. Niku, S. B, Introduction to Robotics: Analysis, Control, Applications. John Wiley & Sons, 2020.

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	3	1	1
CO2	3	-	-	-	3	-	-	-	-	-	3	2	1
CO3	3	3	-	-	-	-	-	-	-	-	3	1	1
CO4	3	3	3	-	3	-	-	-	-	-	3	1	2
CO5	3	3	3	-	3	-	-	-	-	-	3	1	2
Mean	3	2.4	1.2	-	1.8	-	-	-	-	-	3	1.2	1.4

Department : Mechanical Engineering			Programme : B.Tech						
Semester : Sixth			Course Category Code: ANC			Semester Exam Type: TY			
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUN107	Sensors and Actuators	L	T	P	C	CA	SE	TM	
		3	-	-	3	40	60	100	
Prerequisite	Basic electronics, Measurements and Instruments								
Course Outcome  At the end of the course students will be able to	CO1	Understand the basic laws and phenomena on which operation of sensors and actuators used in transformation of energy							
	CO2	Create analytical design and development for sensors and actuators.							
	CO3	Apply the laws of behaviour of sensors and actuators used in mechanical systems.							
	CO4	Apply the standards for smart sensor interface							
	CO5	Analyse, develop and apply sensors and actuators for mechanical automations							
UNIT-I	Sensors & Transducers							Periods: 9	
Sensors / Transducers: Principles, Classification, Parameters, Characteristics, Environmental Parameters (EP), Characterization. Mechanical and Electromechanical Sensors: Introduction, Resistive Potentiometer, Resistance Strain Gauge, Semiconductor Strain Gauges, Capacitive Sensors, Electrostatic Transducer, Ultrasonic Sensors.								CO1	
UNIT-II	Thermal Sensors							Periods: 9	
Thermal Sensors: Introduction, Gas thermometric Sensors, Thermal Expansion Type Thermometric Sensors, Acoustic Temperature Sensor, Dielectric Constant and Refractive Index Thermo-sensors, Nuclear Thermometer, Thermo-EMF Sensors, Thermal Radiation Sensors, Quartz Crystal Thermo-electric Sensors, Spectroscopic Thermometry, Noise Thermometry.								CO2	
UNIT-III	Radiation Sensors							Periods: 9	
Introduction – Basic Characteristics – Types of Photo sensistors– X-ray and Nuclear Radiation Sensors– Fibre Optic Sensors. Electro Analytical Sensors: Introduction – The Electrochemical Cell – The Cell Potential – Standard Hydrogen Electrode (SHE) – Liquid Junction and Other Potentials – Sensor Electrodes.								CO3	
UNIT-IV	Smart Sensors							Periods: 9	
Introduction, Primary Sensors, Excitation, Converters, Compensation, Information Coding/Processing, Data Communication, Standards for Smart Sensor Interface, the Automation. Sensors Applications: Introduction, On-board Automobile Sensors (Automotive Sensors), Home Appliance Sensors..								CO4	
UNIT-V	Actuators							Periods: 9	
Actuators: Pneumatic and Hydraulic Actuation Systems- Actuation systems, Pneumatic and hydraulic systems, Directional Control valves, Pressure control valves, Cylinders, Servo and proportional control valves.								CO5	
Lecture Periods: 45		Tutorial Periods: -		Practical Periods: -		Total Periods: 45			
Reference Books:									
1. Patranabis. D, Sensors and Transducer, Wheeler publisher, 1994.									
2. W. Bolton, —Mechatronics, Pearson Education Limited.									
3. Sergej Fatikow and Ulrich Rembold, Microsystem Technology and Microbotics, First edition, Springer –Verlag New York, Inc, 1997.									
4. Jacob Fraden, Hand Book of Modern Sensors: Physics, Designs and Application Fourth edition, Springer, 2010.									

5. Robert H Bishop, The Mechatronics Hand Book, CRC Press, 2002.
6. Thomas. G. Bekwith and Lewis Buck.N, Mechanical Measurements, Oxford and IBH publishing Co. Pvt. Ltd.,
7. Massood Tabib and Azar, Micro actuators Electrical, Magnetic, thermal, optical, mechanical, chemical and smart structures, First edition, Kluwer academic publishers, Springer, 1997.
8. Manfred Kohl, Shape Memory Actuators, First edition, Springer.

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	-	-	-	-	-	-	1	-	-	-	1	1
CO2	-	3	-	-	-	-	-	2	-	-	-	2	2
CO3	3	-	-	-	-	-	-	2	-	-	-	1	2
CO4	3	-	-	-	-	-	-	2	-	-	-	1	2
CO5	3	3	-	-	-	-	-	2	-	-	-	1	2
Mean	2.2	1.2	-	-	-	-	-	1.8	-	-	-	1.2	1.8

<b>Department : Mechanical Engineering</b>		<b>Programme : B.Tech</b>							
<b>Semester : Seventh</b>		<b>Course Category Code: ANC</b>				<b>Semester Exam Type: TY</b>			
<b>Course Code</b>	<b>Course Name</b>		<b>Periods/week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
<b>MEUN108</b>	<b>Smart Manufacturing</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CA</b>	<b>SE</b>	<b>TM</b>	
		<b>3</b>	<b>--</b>	<b>--</b>	<b>3</b>	<b>40</b>	<b>60</b>	<b>100</b>	
<b>Prerequisite</b>	<b>-</b>								
<b>Course Outcome</b> At the end of the course students will be able to	<b>CO1</b>	Explain the concept of Industry 4.0 for Smart Manufacturing							
	<b>CO2</b>	Apply the use of various hardware used in Smart Manufacturing							
	<b>CO3</b>	Identify the various communication protocols. Hardware and software, iot layers and their relative importance							
	<b>CO4</b>	Develop model for Smart Manufacturing							
<b>UNIT-I</b>	<b>Industry 4.0</b>							<b>Periods: 9</b>	
Industry 4.0 Concept, Globalization and emerging issues, The Fourth Revolution, LEAN manufacturing, Smart and connected business perspectives, Smart factories								CO1	
<b>UNIT-II</b>	<b>Sensors and Controllers</b>							<b>Periods: 9</b>	
Programmable Logic Controller (PLC) and its Programming software, Communication of different devices with PLC, Sensor, Smart Sensor, HMI design, Cyber Physical System – key components, ISA-95 architecture, CPS-5C architecture, Concept of Digit Twin								CO2, CO3	
<b>UNIT-III</b>	<b>Machine Language</b>							<b>Periods: 9</b>	
Protocols – MQTT, OPC UA, Ether Ne t/IP, Profinet, Ether CAT, MQTT – History, MQTT broker, Message types, Quality of Service (QoS), Application; OPC UA – History, Specification, Client, Server, Programming with – Free and open-source software, Propriety software; Augmented Reality								CO2, CO3	
<b>UNIT-IV</b>	<b>Data Processing</b>							<b>Periods: 9</b>	
Data Modelling, IoT platforms – Thing, basic functionalities, Abstract definition of Thing, Networks, etc; IoT Gateway, Machine interfaces – Cloud-based Mosquito brokers, Programming with – Free and open-source software, Propriety software								CO4	
<b>UNIT-V</b>	<b>Optimization</b>							<b>Periods: 9</b>	
Learning algorithms – Supervised, Unsupervised, Self-learning, Feature learning, etc. Models – Artificial Neural Networks, Decision trees, Regression analysis, Genetic algorithms, etc.; Programming with – Free and open-source software, Propriety software								CO2, CO4	
<b>Lecture Periods: 45</b>		<b>Tutorial Periods: -</b>		<b>Practical Periods: -</b>		<b>Total Periods: 45</b>			
<b>Reference Books:</b>									
1. Christoph Jan Bartodziej, The Concept Industry 4.0 – An Empirical Analysis of Technologies and Application in Production Logistics, Spinger Gabler, 2015									
2. Alasdair Gilchrist, Industry 4.0 – The Industrial Internet of Things, Springer Link, 2016									
3. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, ISBN: 978-1-119-99435-0, 2nd Edition, Willy Publications									
4. W. Botton, Programmable Logic Controllers, Fourth Edition, Elsevier, 2006									
5. Daniel Minoli, Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, ISBN: 978-1-118-47347-4, Willy Publications.									
6. Michahelles, Architecting the Internet of Things, ISBN 978-3- 642-19156-5 e-ISBN 978- 3- 642-19157-2, Springer.									
7. Hakima Chaouchi, The Internet of Things Connecting Objects to the Web ISBN : 978-1- 84821-140-7, Willy Publications.									

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	-	-	2	-	-	-	-	-	2	1	2
CO2	3	-	-	-	2	-	-	-	-	-	2	2	2
CO3	3	-	-	-	-	2	2	-	-	-	2	2	1
CO4	3	3	-	-	3	-	-	-	-	-	2	3	2
Mean	3	0.8	-	-	1.8	0.5	0.5	-	-	-	2	2	1.8

## Ancillary Stream Electives – III

Ancillary Stream Title	Course Code	Course	Semester
<b>Industry 4.0 (only for Mechanical students)</b>	MEUI101	AI in Manufacturing Engineering	<b>IV, V, VI, VII</b>
	MEUI102	ML Applications in Mechanical Engineering	
	MEUI103	Fault Diagnosis and Signal Processing	
	MEUI104	Additive Manufacturing	

Department : Mechanical Engineering			Programme : B.Tech (ME)						
Semester : Fourth			Course Category Code: ANC				Semester Exam Type: TY		
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUI101	AI in Manufacturing Engineering		L	T	P	C	CA	SE	TM
			3	-	-	3	40	60	100
Prerequisite	-								
Course Outcome At the end of the course students will be able to	CO1	Explain the aspects of artificial intelligence, in the context of manufacturing engineering.							
	CO2	Apply the use of various hardware used in Smart Manufacturing							
	CO3	Identify the various communication protocols. Hardware and software, iot layers and their relative importance							
	CO4	Identify tools required for creating artificial intelligence applications in the manufacturing domain.							
UNIT-I	Introduction to Artificial Intelligence (AI)							Periods: 9	
History of AI, Comparison of AI with Data Science, Need of AI in Mechanical Engineering, reasoning, problem solving, knowledge representation, planning, learning, perception, motion and manipulation - Artificial intelligence: components, scope and application areas.								CO1	
UNIT-II	Machine Learning							Periods: 9	
Introduction: Basic definitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation. Linear regression, Decision trees, over fitting. Instance based learning, Feature reduction, Collaborative filtering based recommendation. Probability and Bayes learning, Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM. Computational learning theory, PAC learning model, Sample complexity, VC Dimension, Ensemble learning- case studies								CO2, CO3	
UNIT-III	AI in Robotics							Periods: 9	
Reinforcement Learning- planning and search, localization, tracking, mapping and control- A* search algorithms- path smoothing algorithms - SLAM algorithm- Precision agriculture- Assistance robots-Robot Performance optimization-Case studies								CO2, CO3	
UNIT-IV	Deep Learning							Periods: 9	
Fundamentals of deep learning - Gradient-Based learning - Back-Propagation - Activation functions - Feature learning - Convolution Neural Networks (CNN) - Recurrent Neural Networks - Deep Feed – forward networks Platform for deep learning - Deep learning software libraries - Applications of deep learning - Case studies on application of deep learning - Deep learning enabled advanced analytics for smart manufacturing								CO4	
UNIT-V	AI applications							Periods: 9	
Fault diagnosis- Quality inspection- Improving the safety of working places- Material modelling and smart materials-Automobile engineering- building self-driving cars and autonomous vehicles, Auto parking-Machine learning in Machine Tools and Manufacturing Industries								CO2, CO4	
Lecture Periods: 45		Tutorial Periods: -		Practical Periods: -			Total Periods: 45		
Reference Books:									
1. Clocksin, W. F. and C. S. Mellish, Programming in PROLOG, Narosa Publishing House, New Delhi.									
2. Giarratano, J. C. and G. D. Riley, Expert Systems - Principles and Programming, Cengage Learning, New Delhi.									

3. Padhy, N. P., Artificial Intelligence and Intelligent Systems, Oxford University Press, New Delhi.
4. Rajasekaran, S. and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms, PHI Learning Private Limited, New Delhi.

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	-	-	2		-	-	-	-	2	2	1
CO2	3	-	-	-	2		-	-	-	-	2	2	1
CO3	3	-	-	-	-	2	2	-	-	-	-	2	1
CO4	3	3	-	-	3			-	-	-	2	2	1
Mean	3	0.8	-	-	1.8	0.5	0.5	-	-	-	1.5	2	1

Department : Mechanical Engineering			Programme : B.Tech (ME)					
Semester : Fifth			Course Category Code: ANC			Semester Exam Type: TY		
Course Code	Course Name		Periods/week			Credit	Maximum Marks	
MEUI102	ML Applications in Mechanical Engineering	L	T	P	C	CA	SE	TM
		3	-	-	3	40	60	100
Prerequisite	-							
Course Outcome  At the end of the course students will be able to	CO1	Understand the basic concepts of artificial intelligence in mechanical engineering with industrial applications and its scope.						
	CO2	Understand the basic concepts of artificial intelligence including a basic knowledge of the different classifiers used in machine learning						
	CO3	Develop capability to apply the basic concepts of AI and ML to Automation and in different manufacturing systems.						
	CO4	Apply the knowledge and concepts of machine learning to problems in industrial engineering.						
	CO5	Apply the knowledge and concepts of machine learning to problems in production engineering.						
UNIT-I	Introduction to Machine Learning						Periods: 9	
Introduction and basic concepts - Need for machine learning - Types of machine learning - Supervised, Unsupervised learning - Reinforced learning - Deep Learning Versus Machine Learning - Relation between - Machine Learning and Statistics - Machine Learning methods based on time – Static learning - Machine Learning methods based on time – Dynamic learning - Function Approximation							CO1	
UNIT-II	Supervised and Unsupervised learning						Periods: 9	
Supervised Learning – Classification - Artificial Neural Networks - Bayesian models - Decision trees - Support vector machines - K-nearest neighbour clustering - Regression analysis - Linear regression – Multiple linear regression - Logistic regression Model representation - Unsupervised Learning - Clustering, types of clustering - K - means clustering - Dimensionality reduction - Semi-supervised -learning - Expectation maximization - Hybrid Learning techniques							CO2, CO3	
UNIT-III	Reinforced learning						Periods: 9	
Elements of Reinforcement learning - Multi-armed Bandits - Finite Markov Decision Processes – The agent – Environment Interface - Goals and Rewards, Returns and Episodes - Unified Notation for Episodic and Continuing Tasks - Policies and Value functions - Optimal Policies and Optimal Value Functions - optimality and Approximation - Dynamic Programming - Policy Evaluation, Policy improvement, Policy iteration, Value iteration - Monte-Carlo Reinforcement Learning - Temporal Difference Learning							CO2, CO3	
UNIT-IV	ML Algorithms						Periods: 9	
Random forest algorithm (RFA) – Decision tree – binary decision tress, pruning – Bayesian network, applications – Support vector Machine algorithm (SVR) – deep learning concepts – Artificial Neural networks (ANN) – training data, hidden layers, and predicted output – Introduction to perceptron.							CO4	
UNIT-V	ML applications						Periods: 9	
Applications of machine learning in Industrial sectors - Energy sector: oil and gas - Basic materials sector: Chemicals and Basic resources - Industrials sector - Industrial manufacturing - Industry 4.0: Introduction - Industry smartization - Industry smartization; Component level case study - Industry smartization: Machine level case study - Industry smartization; Production level case study - Industry smartization:							CO2, CO4	

Distribution level case study - Machine Learning Challenges and Opportunities within Smart Industries			
<b>Lecture Periods: 45</b>	<b>Tutorial Periods: -</b>	<b>Practical Periods: -</b>	<b>Total Periods: 45</b>
<b>Reference Books:</b> <ol style="list-style-type: none"> <li>1. Hands on Machine Learning with Python: Concepts and Applications for Beginner, John Anderson, AI Sciences 2018</li> <li>2. Hands on Machine Learning with Scikit-learn and Tensor Flow, Aurelien Geron, O'Reilly Publishers, 2016.</li> <li>3. Introduction to Operations Research, Lieberman, G. J., &amp; Hillier, F. S. New York, NY, USA: McGraw-Hill, (2015).</li> <li>4. Sutton, Richard S., and Andrew G. Barto. Reinforcement learning: An introduction. MIT press, 2018.</li> <li>5. Larrañaga, P., Atienza, D., Diaz-Rozo, J., Ogbechie, A., Puerto-Santana, C. E., &amp; Bielza, C., Industrial Applications of Machine Learning. CRC Press, 2018.</li> </ol>			

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	3	2	3	-	-	-	-	-	1	-	2	1
<b>CO2</b>	3	3	2		-	-	-	-	-	1	-	2	1
<b>CO3</b>	3	3	-	-	-	-	-	-	-	1	-	2	1
<b>CO4</b>	3	2	-	2	-	-	-	-	-	1	-	2	1
<b>CO5</b>	3	2	2	1	-	-	-	-	-	1	-	2	1
<b>Mean</b>	<b>3</b>	<b>2.6</b>	<b>1.2</b>	<b>1.2</b>	-	-	-	-	-	<b>1</b>	-	<b>2</b>	<b>1</b>

Department : Mechanical Engineering		Programme : B.Tech (ME)						
Semester : Sixth		Course Category Code: ANC				Semester Exam Type: TY		
Course Code	Course Name	Periods/week			Credit	Maximum Marks		
MEUI103	Fault Diagnosis and Signal Processing	L	T	P	C	CA	SE	TM
		3	-	-	3	40	60	100
Prerequisite	-							
Course Outcome At the end of the course students will be able to	CO1	Analyse failure modes and signal analysis through maintenance in machines						
	CO2	Analyse the vibration signals from machines.						
	CO3	Use the measurement techniques in fault diagnosis.						
	CO4	Apply fault detection techniques for fault diagnosis in rotating and reciprocating machines						
UNIT-I	Machine Fault Diagnostics and Failure Analysis							Periods: 9
Introduction – Principles of maintenance – Failure mode effect and criticality analysis - Fault Diagnostics and Prognostics - Reactive maintenance, preventive maintenance, predictive maintenance, enterprise resource planning, bathtub curve, failure modes effect and criticality analysis (FMECA), Classification of signals, signal analysis, frequency domain signals analysis, fundamental of fast Fourier transform, computer aided data acquisition, signal conditioning, signal demodulation, Cepstrum analysis - Hilbert Transform in Condition Monitoring.								CO1
UNIT-II	Measurement for Machine Diagnostics							Periods: 9
Measurement standards, measurement errors, calibration principles, static and dynamic measurements, frequency response, dynamic range, basic measuring equipment, vibration force measurement, laser based measurement, current measurement, chemical composition measurement, ultrasonic thickness measurement, data recorders								CO1 CO2
UNIT-III	Sensors for Condition Monitoring							Periods: 9
Temperature sensors, Displacement sensors, Pressure sensors, Flow sensors, Smart Sensors - Mechanical - electronic, transitions in sensing. Non-destructive testing in condition monitoring-Introduction, visual examination, Liquid penetrant testing, Magnetic particle testing, Eddy current testing, Radiography, Ultrasonic testing, NDT by AE sensors and Leak testing								CO1 CO2 CO3
UNIT-IV	Signal Conditioning and Operational Amplifier Circuits							Periods: 9
Principles of signal – conditioning, Common signal conditioning operations, Operational amplifiers, Filters, integrator, differentiator, comparator, logarithmic amplifier. Voltage to current converter, current to voltage converter, voltage-controlled oscillator, Noise and Noise reduction techniques, induced noise, grounding, shielding, filtering, Sound intensity measurement								CO3 CO4
UNIT-V	Fault Deduction							Periods: 9
Introduction to Faults in Rotating Machines - Unbalance Detection - Field Balancing – Misalignment - Crack and Looseness - Journal and Anti-Friction Bearings – Gears - Pumps and Cavitation - IC Engines - Machinery Diagnostic Chart. Introduction to Failure Analysis - Railway Locomotive Noise and Vibration Monitoring - Paper Mill Vibration Monitoring - Future of Condition based Monitoring								CO4
Lecture Periods: 45		Tutorial Periods: -		Practical Periods: -		Total Periods: 45		
Reference Books:								
1. A.R. Mohanty, Machinery Condition Monitoring – Principles and Practices – CRC Press, 2014,								

2. R. A Collacott, Mechanical Fault Diagnosis and condition monitoring, Springer.
3. A. Davis, Handbook of condition monitoring, Springer Science Business media.
4. R.C Eisenmann, Machinery malfunction diagnosis and correction, Prentice Hall.
5. Collacot, Mechanical Fault Diagnosis and Condition Monitoring, Chapman Hall 1987
6. Davies, Handbook of Condition Monitoring: Techniques and Methodology, Springer -1998
7. Norton M. and Karczub D. Fundamentals of Noise and Vibration Analysis for Engineers, Cambridge University Press, 2<sup>nd</sup> Edition, 2003
8. Duda R. O., Peter Hart E., and Stork D. E. Pattern Classification, Wiley India, 2<sup>nd</sup> Edition 2007

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	-	2	-	-	-	-	-	-	-	1	1
CO2	2	3	-	2	-	-	-	-	-	-	-	1	1
CO3	-	-	2	2	-	-	-	-	-	-	-	1	1
CO4	2	2	-	2	-	-	-	-	-	-	-	1	1
Mean	1.8	2	0.5	2	-	-	-	-	-	-	-	1	1

Department : Mechanical Engineering		Programme: B.Tech (ME)							
Semester : Seventh		Course Category Code: ANC				Semester Exam Type: TY			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
MEUI104	Additive Manufacturing		3	-	-	3	40	60	100
Prerequisite:									
Course Outcome At the end of the course students will be able to	CO1	Understand the concept of engineering design and associated aspects of manufacturing, assembly, ergonomics, and environment							
	CO2	Apply Product Development Cycle concepts in new product development and relate it to need for Rapid Prototyping							
	CO3	Determine Pre-processing and Post-Processing stages in Additive Manufacturing Process with emphasis on technology, benefits, and functional aspects							
	CO4	Understand and illustrate types of 2-D and Direct 3-D Additive Manufacturing Process for Rapid Prototyping in Product development							
UNIT-I						Periods: 9			
Basic concepts of Design, Information in Design, Issues in Design, Tools for Design, Theories of Design									CO1 CO2
UNIT-II						Periods: 9			
Product development cycle, Data requirements, Data representation, Modelling, Part orientation and Support, Slicing, STL format									CO2 CO3
UNIT-III						Periods: 9			
Engineering Manufacturing, Existing Prototyping and Tooling Techniques, Features and Classification of Additive Manufacturing Processes									CO2 CO4
UNIT-IV						Periods: 9			
Two Dimensional Layer- by Layer Techniques, Stereo-lithography (SL), Fused Deposition Modelling (FDM), Laminated Object Manufacturing (LOM), Selective Laser Sintering (SLS), Solid Ground Curing (SGC)									CO3
UNIT-V						Periods: 9			
Direct Three-Dimensional Techniques, Beam Interference Solidification (BIS), Ballistic Particle Manufacturing, Programmable Moulding, Comparison of AMP characteristics, Consideration for adopting to RP technology									CO3, CO4
Lecture Periods: 45		Tutorial Periods: -		Practical Periods:-			Total Periods: 45		
Reference Books:									
1. Amitabha Ghosh; Rapid Prototyping – A Brief Introduction, Affiliated East West Press Pvt. Ltd., 1997									
2. Hari Prasad, A.V. Suresh; Additive Manufacturing Technology, Cengage, 2020									
3. C.P.Paul, A.N. Jinoop; Additive Manufacturing – Principles, Technologies and Applications, Mc Graw Hill, 2021									
4. Richard Bizmingham,Graham Cleland, Robert Driver and Dwid Maffin; Understanding Engineering Design, Printice Hall of India, 2000									
5. Radhakrishnan.P, Subramanya.S, and Raju.V; CAD/CAM/CIM, New Age International Pvt. Ltd, 2019									
6. Tuhin Mukherje, Tarasankar DebRoy Theory and Practice of Additive Manufacturing; WILEY, 2023									

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	3	-	2	2	-	-	1	-	-	-	1	-
CO2	2	-	1	-	-	-	-	-	-	-	-	-	1
CO3	-	-		3	2	1	2	-	-	-	-	-	2
CO4	-	-	-	-	2	1	2	-	-	-	-	-	2
CO5	-	-	-	-	-	-	-	-	-	-	-	-	
Mean	0.5	0.8	0.3	1.3	1.5	0.5	1	0.3				0.3	1.3

Annexure III	Syllabi of the <i>Honours Courses</i> offered by the Mechanical Engineering Department
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# HONOURS COURSES

<b>Course Code</b>	<b>Course</b>	<b>Semester</b>
MEUH101	Hydrogen Energy and Fuel Cell	<b>IV</b>
MEUH102	Failure Analysis and Prevention	<b>V</b>
MEUH103	Reliability Engineering	<b>VI</b>
MEUH104	Engineering Optimization	<b>VII</b>
MEUH105	Seminar	<b>VIII</b>

<b>Department: Mechanical</b>		<b>Programme: B.Tech (ME) - Honours</b>						
<b>Semester: Fourth</b>		<b>Course Category Code: PCC</b>			<b>Semester Exam Type: TY</b>			
<b>Course Code</b>	<b>Course Name</b>	<b>Periods / Week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
		<b>L</b>	<b>T</b>	<b>P</b>		<b>CA</b>	<b>SE</b>	<b>TM</b>
<b>MEUH101</b>	<b>Hydrogen Energy and Fuel Cells</b>	<b>3</b>	<b>1</b>	<b>-</b>	<b>4</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>Prerequisite</b>	<b>-</b>							
<b>Course Outcome</b> At the end of the course students will be able to	<b>CO1</b>	Understand the characteristic of hydrogen energy, its properties and production methods.						
	<b>CO2</b>	Apply different methods of Hydrogen Energy Storage, Transportation and Applications.						
	<b>CO3</b>	Acquire knowledge in handling, safety measures and environmental aspects of hydrogen.						
	<b>CO4</b>	Understand fuel cell operation and types of fuel cell.						
	<b>CO5</b>	Apply fuel cells in transport applications and its economics.						
<b>UNIT I</b>	<b>Hydrogen Energy</b>					<b>Periods: 12</b>		
Hydrogen as an energy source – Properties of hydrogen – Combustion methods and devices – Economics of hydrogen energy – Production of hydrogen: natural resource – biological source - electrolytic process – thermal decomposition – biochemical method – photochemical method – photo-catalytic method.								<b>CO1</b>
<b>UNIT II</b>	<b>Hydrogen Energy Storage, Transportation and Applications</b>					<b>Periods:12</b>		
Selection of storage: Gaseous, liquid – Method of storage: Gaseous hydrogen, cryogenic method, metal hydrides, carbon Nano-tubes, sea as a source of deuterium – Transportation: methods of transport – cryo-cooled systems –Fuel cells – Applications of hydrogen energy in land and space vehicles – Hydrogen power technologies.								<b>CO2</b>
<b>UNIT III</b>	<b>Safety and environmental aspects of hydrogen</b>					<b>Periods: 12</b>		
Hydrogen sensing and detection: hydrogen measuring principles – traditional sensing methods: thermal conductivity, gas chromatography, mass spectroscopy, laser gas analysis – solid-state sensing techniques –operation mechanisms of solid-state sensors – hydrogen sensors for industrial processes – sensors in hydrogen fuel applications – hydrogen safety: hydrogen hazards – hazards in hydrogen storage facilities – hazards in using hydrogen as fuel in transport sectors – hydrogen codes and standards: national codes – national templates – selected highlights of national templates – key issues: performance based versus prospective standards – coordination of international and domestic standards.								<b>CO3</b>
<b>UNIT IV</b>	<b>Fuel cell</b>					<b>Periods: 12</b>		
Fuel cell operation – low-to-medium temperature fuel cells: phosphoric acid fuel cell, alkaline fuel cell, direct borohydride fuel cell, proton-exchange membrane fuel cell, direct methanol fuel cell, miniature fuel cells – high temperature fuel cells: Molten carbonate fuel cell, direct carbon fuel cell, solid oxide fuel cell – fuel cell efficiencies.								<b>CO4</b>
<b>UNIT V</b>	<b>Fuel cell applications and economics</b>					<b>Periods: 12</b>		
Applications of fuel cells – prognosis for fuel cells – fuel cells in dispersed-energy systems (Utility use) – Fuel cells in on-site Integrated energy systems and Industrial co-generation – Fuel cell commercial availability – market and cost analysis of fuel cell technology – environmental aspects and impact assessment.								<b>CO5</b>
<b>Lecture Periods: 45</b>		<b>Tutorial Periods: -15</b>		<b>Practical Periods: -</b>		<b>Total Periods: 60</b>		
<b>Reference Books:</b>								
1. Karl V. Kordesch, Dr. Günter R. Simader, Fuel Cells: and their Applications, Wiley Publications, 1996.								
2. Ram B. Gupta, Hydrogen Fuel: Production, Transport and Storage, CRC Press, 2009.								

3. Jamasb, T., Pollitt, M. G. and Nuttall, W. J., Future Electricity Technologies and Systems, Cambridge University Press, 2006
4. Ryan O'Hare, Suk-Won Cha, Whitney Colella, Fritz B. Prinz., Fuel Cell Fundamentals, John Wiley & Sons Inc., 2nd Edition, 2009.

### **CO – PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	-	-	-	-	1	-	-	-	-	-	1	1
<b>CO2</b>	2	1	-	-	-	1	-	-	-	-	1	2	2
<b>CO3</b>	2	-	-	-	-	1	-	-	-	-	1	2	2
<b>CO4</b>	2	-	-	-	-	1	-	-	-	-	1	2	2
<b>CO5</b>	2	1	-	-	-	1	-	-	-	-	1	2	2
<b>Mean</b>	<b>2.2</b>	<b>0.4</b>	-	-	-	<b>1</b>	-	-	-	-	<b>0.8</b>	<b>1.8</b>	<b>1.8</b>

Department : Mechanical Engineering			Programme : B.Tech (ME) - Honours						
Semester : Fifth			Course Category Code: PCC			Semester Exam Type: TY			
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUH102	Failure Analysis and Prevention	L	T	P	C	CA	SE	TM	
		3	1	--	4	40	60	100	
Prerequisite	-								
Course Outcome At the end of the course students will be able to	CO1	Analyze the role of failure mechanics.							
	CO2	Demonstrate the analysis of the elastic-plastic fracture mechanics.							
	CO3	Determine solutions for the prediction of fatigue life of machine components.							
	CO4	Explain the significance of creep and low-cycle fatigue.							
	CO5	Explain the role and significance of different types of wear.							
UNIT-I	Fracture mechanics						Periods: 12		
Fracture mechanics: Introduction, role of failure prevention analysis in mechanical design, some design objectives, definition of failure mode, types of failure modes, glossary of mechanical failure modes. Linear Elastic Fracture Mechanics (LEFM), three modes of failure, use of fracture mechanics in design, stress intensity factors, fracture toughness, elastic-plastic fracture mechanics, plastic zone correction factors, Dugdale approach, simple problems.								CO1	
UNIT-II	Fatigue cracks and Analysis						Periods: 12		
Fatigue cracks and analysis: Introduction to fatigue, nature of fatigue, fatigue loading, fracture phases, release rate, example of a Double Cantilever Beam (DCB), crack resistance and J-Integral, simple problems.								CO2, CO3	
UNIT-III	Fatigue						Periods : 12		
Low-cycle fatigue: Introduction, strain cycling concept, strain life curve and low cycle fatigue relationships, influence of non-zero mean strain and non-zero mean stress, cumulative damage rule in low cycle fatigue.								CO2, CO3	
UNIT-IV	Creep						Periods : 12		
Creep in materials: Introduction to creep, long-term behavior of materials, mechanism and causes of creep, influence of stress and temperature, phases of creep, creep strength, relaxation, mathematical modelling of creep behavior Maxwell and Voigt-Kelvin models, simple problems.								CO4	
UNIT-V	Wear and Corrosion						Periods: 12		
Fretting, wear and corrosion: Introduction to fretting failure, variables of importance in the fretting process, fretting fatigue, fretting wear, fretting corrosion, prevention of fretting damage. Introduction to wear - adhesive wear, abrasive wear, surface fatigue, deformation, wear coefficient Corrosion, causes of corrosion, types of corrosion, corrosion wear, stress corrosion cracking, prevention of corrosion.								CO2, CO4	
Lecture Periods: 45		Tutorial Periods: 15		Practical Periods: -		Total Periods: 60			
Reference Books:									
1. Jack A. Collins, Failure of Materials in Mechanical Design, 2nd Edition, Wiley Inter science Publishers, 2013.									
2. Prashant Kumar, Elements of Fracture Mechanics, Wheeler Publishing, 1999.									
3. David Broek, Fifthoff and Noerdhoff, Elementary Engineering Fracture Mechanics, 4th Edition, Springer Publishers, 2013.									

4. Ewalds, H.L. and Wanhill, R.J.H., Fracture Mechanics, Edward Arnold Edition, 1999.
5. Surjya Kumar Maiti, Fracture Mechanics - Fundamental and Applications, Cambridge University Press, Delhi 2015.
6. Gope, P.C., Machine Design Fundamentals and Applications, PHI Learning Private Limited, New Delhi, 2012.

### **CO-PO Mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	3	3	2	3	-	-	-	-	-	1	-	2	1
<b>CO2</b>	3	3	2	-	-	-	-	-	-	1	-	2	1
<b>CO3</b>	3	3	-	-	-	-	-	-	-	1	-	2	1
<b>CO4</b>	3	2	-	2	-	-	-	-	-	1	-	2	1
<b>CO5</b>	3	2	2	1	-	-	-	-	-	1	-	2	1
<b>Mean</b>	<b>3</b>	<b>2.6</b>	<b>1.2</b>	<b>1.2</b>	-	-	-	-	-	<b>1</b>	-	<b>2</b>	<b>1</b>

Department : Mechanical Engineering			Programme : B.Tech (ME) - Honours						
Semester : Sixth			Course Category Code: PCC			Semester Exam Type: TY			
Course Code	Course Name		Periods/week			Credit	Maximum Marks		
MEUH103	Reliability Engineering	L	T	P	C	CA	SE	TM	
		3	1	--	4	40	60	100	
Prerequisite	-								
Course Outcome At the end of the course students will be able to	CO1	Analyze the role of failure models in design							
	CO2	Demonstrate and evaluate the reliability of the systems.							
	CO3	Determine the probability of life of machine components.							
	CO4	Apply mathematical and IT tools to measure the reliability of the systems.							
	CO5	Apply the reliability theory in real time industrial systems.							
UNIT-I	Basic Probability Theory						Periods: 12		
Basic concepts – Rules for combining Probabilities of events – Failure Density and Distribution functions – Bernoulli’s trials – Binomial distribution – Expected value and standard deviation for binomial distribution – Examples								CO1	
UNIT-II	Network Modelling and Reliability Evaluation						Periods: 12		
Basic concepts – Evaluation of network Reliability / Unreliability – Series systems, Parallel systems, Series - Parallel systems, partially redundant systems – Types of redundancies - Evaluation of network Reliability / Unreliability using conditional probability method – Paths based and Cutset based approach – complete event tree and reduced event tree methods - Examples.								CO2, CO3	
UNIT-III	Time Dependent Probability						Periods : 12		
Basic concepts – Reliability functions f(t), F(t), R(t), h(t) – Relationship between these functions – Baths tubs curve – Exponential failure density and distribution functions - Expected value and standard deviation of Exponential distribution – Measures of reliability – MTTF, MTTR, MTBF – Evaluation of network reliability / Unreliability of simple Series, Parallel, Series-Parallel systems - Partially redundant systems - Evaluation of reliability measure – MTTF for series and parallel systems – Examples.								CO2, CO3	
UNIT-IV	Discrete Markov Chains & Continuous Markov Processes						Periods : 12		
Basic concepts – Stochastic transitional Probability matrix – time dependent probability evaluation – Limiting State Probability evaluation – Absorbing states – Markov Processes-Modelling concepts – State space diagrams – time dependent reliability evaluation of single component repairable model – Evaluation of Limiting State Probabilities of one, two component repairable models – Frequency and duration concepts – Frequency balance approach - Examples.								CO4	
UNIT-V	Multi Component & Approximate System Reliability Evaluation						Periods: 12		
Recursive relation for evaluation of equivalent transitional rates, cumulative probability and cumulative frequency and ‘n’ component repairable model - Series systems, Parallel systems, Basic reliability indices – Cutset approach – Examples.								CO2, CO4	
Lecture Periods: 45		Tutorial Periods: 15		Practical Periods: -		Total Periods: 60			
Reference Books:									
1. V. Sankar, System Reliability Concepts, Himalaya Publishing House, 2015.									
2. Roy Billinton and Ronald N. Allan, Reliability Evaluation of Engineering Systems, Reprinted in India B. S. Publications, 2007.									
3. E. Balagurusamy, Reliability Engineering, Tata McGraw Hill, 2003.									
4. Charles E. Ebeling, Reliability and Maintainability Engineering, Tata McGraw Hill, 2000.									

5. G.J. Anders, Probability concepts in Electric Power system, 1<sup>st</sup> edition –1990 – John wiley & sons.

### **CO-PO Mapping**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PSO1</b>	<b>PSO2</b>
<b>CO1</b>	3	3	2	3	-	-	-	-	-	-	-	2	1
<b>CO2</b>	3	3	2	-	-	-	-	-	-	-	-	2	1
<b>CO3</b>	3	3	-	-	1	-	-	-	-	-	-	2	1
<b>CO4</b>	3	2	2	2	1	-	-	-	-	-	-	2	1
<b>CO5</b>	3	2	2	1	-	-	-	-	-	-	-	2	1
<b>Mean</b>	<b>3</b>	<b>2.6</b>	<b>1.6</b>	<b>1.2</b>	<b>0.4</b>	-	-	-	-	-	-	<b>2</b>	<b>1</b>

<b>Department : Mechanical Engineering</b>		<b>Programme : B.Tech (ME) - Honours</b>						
<b>Semester : Seventh</b>		<b>Course Category Code: PCC</b>				<b>Semester Exam Type: TY</b>		
<b>Course Code</b>	<b>Course Name</b>	<b>Periods/week</b>			<b>Credit</b>	<b>Maximum Marks</b>		
<b>MEUH104</b>	Engineering Optimization	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>CA</b>	<b>SE</b>	<b>TM</b>
		<b>3</b>	<b>1</b>	<b>-</b>	<b>4</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>Prerequisite</b>	<b>-</b>							
<b>Course Outcome</b> At the end of the course students will be able to	<b>CO1</b>	Understand the formulation of optimization problem.						
	<b>CO2</b>	Understand the different types of optimization problems.						
	<b>CO3</b>	Acquire knowledge about modern methods of optimization.						
	<b>CO4</b>	Write algorithm to obtain optimal systems.						
<b>UNIT-I</b>	<b>Introduction to Optimization</b>							<b>Periods: 12</b>
Introduction-Optimization Problem Formulation, Design Variables, Constraints, Objective Function, Variable Bounds, Engineering Optimization Problems, Optimization Algorithms.								CO1 CO2
<b>UNIT-II</b>	<b>Single variable Optimization</b>							<b>Periods: 12</b>
Single variable optimization problems-optimality criteria, bracketing methods - exhaustive search method, bounding phase method. Region elimination methods-interval halving method, Fibonacci search method, golden section search method. Point estimation method-successive quadratic estimation method. Gradient based methods - Newton-Raphson method, bisection method and secant method.								CO1 CO2
<b>UNIT-III</b>	<b>Multivariable Optimization</b>							<b>Periods : 12</b>
Multivariable optimization algorithms-optimality criteria, unidirectional search, direct search methods - simplex search method, Hooke-Jeeves pattern search method, Powell's conjugate direction method. Gradient based methods -Cauchy's steepest descent method. newton's method, Marquardt's method. Conjugate gradient method, variable-metric method								CO1 CO2 CO3
<b>UNIT-IV</b>	<b>Constrained Optimization</b>							<b>Periods : 12</b>
Constrained optimization algorithms - Kuhn Tucker Conditions(KTC), Transformation Methods-Penalty function method, Method of multipliers, Direct search methods – Random search method – variable elimination method, Linearized search methods – Frank-Wolfe method – cutting plane method, Gradient Projection method.								CO2 CO3 CO4
<b>UNIT-V</b>	<b>Modern Methods of Optimization</b>							<b>Periods: 12</b>
Non-Traditional optimization Algorithms - Genetic Algorithms GA: GA operators, GAs for constrained optimization. Simulated Annealing-Analogy, Algorithm, Ant Colony Optimization – Applications								CO1 CO2, CO4
<b>Lecture Periods: 45</b>		<b>Tutorial Periods: 15</b>		<b>Practical Periods: -</b>		<b>Total Periods: 60</b>		
<b>Reference Books:</b>								
1. Kalyanmoy Deb, Optimization for engineering design: algorithms and examples. Prentice-Hall of India Private Limited, New Delhi 2010.								
2. Singiresu S Rao, Engineering optimization: theory and practice. Fourth Edition, New Age International(P) Limited Publishers, New Delhi, 2009								
3. Ravindran, K. M. Ragsdell, G. V. Reklaitis, Engineering optimization - methods and applications. Second Edition, John Wiley & Sons, Inc. 2006.								
4. Andreas Antoniou and Wu-Sheeng Lu, Practical Optimization: Algorithms and applications, Springer Science and Business Media, 2007 .								

### **CO-PO Mapping**

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PSO1</b>	<b>PSO2</b>
<b>CO1</b>	2	2	-	2	-	-	-	-	-	-	-	1	-
<b>CO2</b>	2	2	-	-	3	-	-	-	-	-	-		1
<b>CO3</b>	2	2	-	-	2	-	-	-	1	-	-	-	2
<b>CO4</b>	2	1	-	-	2	-	-	-	2	-	-	-	1
<b>Mean</b>	<b>2.0</b>	<b>1</b>	-	<b>0.5</b>	<b>1.8</b>	-	-	<b>0.8</b>	<b>0.8</b>		<b>0.5</b>	<b>0.3</b>	<b>1</b>

<b>Department : Mechanical Engineering</b>				<b>Programme : B.Tech (ME) - Honours</b>				
<b>Semester : Eighth</b>				<b>Course Category Code: PCC</b>			<b>Semester Exam Type: -</b>	
<b>Course Code</b>	<b>Course Name</b>	<b>Periods / Week</b>			<b>Credit</b>		<b>Maximum Marks</b>	
		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>		<b>CA</b>	<b>SE</b> <b>TM</b>
<b>MEUH105</b>	<b>Seminar</b>	-	-	<b>4</b>	<b>2</b>		<b>100</b>	<b>-</b> <b>100</b>
<b>Prerequisite:</b>		-						
<b>Course Outcome</b> At the end of the course students will be able to	<b>CO1</b>	Carry out literature survey, understand state of art techniques.						
	<b>CO2</b>	Apply theoretical knowledge to real-world scenarios or case studies						
	<b>CO3</b>	Take initiative in exploring topics beyond the curriculum and developing self-directed research habits						
	<b>CO4</b>	Present complex ideas concisely and clearly						
	Students are trained for presentation skills through presentation of seminar. Each student will be assigned a topic in the current and frontier areas related to their honours courses. The students are to conduct a detailed study/survey on the assigned topic and prepare a report. Each student will make an oral presentation followed by a brief question and answer session.							CO1, CO2, CO3, CO4
<b>Lecture Periods:-</b>		<b>Tutorial Periods:-</b>			<b>Practical Periods: 60</b>		<b>Total Periods: 60</b>	

### CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
<b>CO1</b>	2	2	-	1	-	-	-	1	-	-	-	-	-
<b>CO2</b>	2	2	-	1	-	-	-	1	-	-	-	-	-
<b>CO3</b>	2	2	-	1	-	-	-	1	-	-	-	-	-
<b>CO4</b>	1	1	-	-	-	-	-	1	3	-	2	-	-
<b>Mean</b>	1.8	1.8	-	0.8	-	-	-	1	0.8	-	0.5	-	-