NEW HORIZON COLLEGE OF ENGINEERING

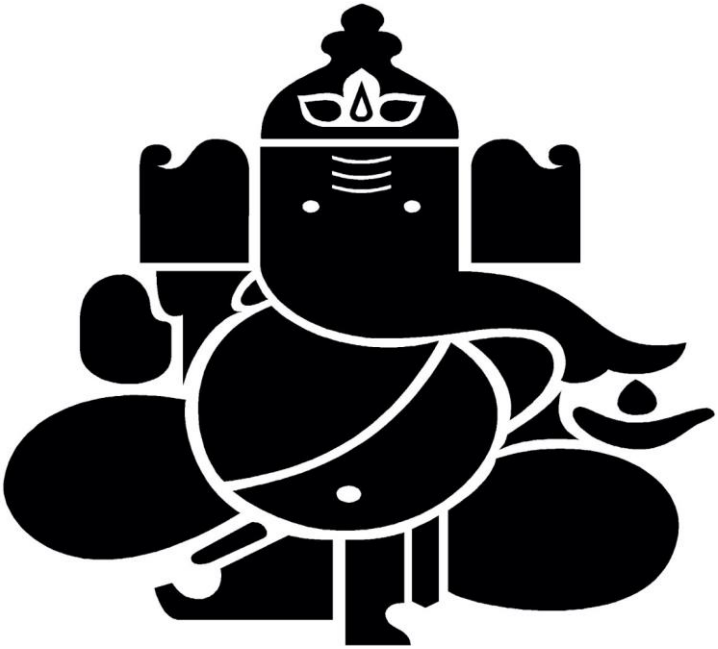
Autonomous College Permanently Affiliated to VTU, Approved by AICTE & UGC
Accredited by NAAC with 'A' Grade, Accredited by NBA

The Trust is a Recipient of Prestigious Rajyotsava State Award 2012 Conferred by the Government of Karnataka
Awarded Outstanding Technical Education Institute in Karnataka-2016
Ring Road, Bellandur Post, Near Marathalli, Bangalore -560 103, INDIA

2015 BATCH

BE - Mechanical Engineering

Fifth and Sixth Semesters
Scheme and Syllabus



CONTENTS

VISION

To create competent mechanical engineers capable of working in diversified disciplines for transformative impact on societal progressive development in the field of mechanical engineering through creative research and lifelong learning.

MISSION

- To impart excellent education by providing the state of art research facilities in the field of mechanical engineering.
- To develop alliances with industries and other organizations for excellence in teaching learning process, research and consultancy projects.
- To enhance the knowledge of students in intellectual, entrepreneurial and ethical challenges through active participation by critical thinking.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1: To prepare students with overall knowledge in Mechanical Engineering and also in the field of Mathematics, Science, Communication and Computing skills and enabling them to understand specific problem areas and find the optimum solutions for the same.

PEO 2: To prepare students to implement ideas of Mechanical Engineering for the challenging task in the interdisciplinary area like Electrical, Electronics, Computer Science, Civil, Bio-Technology and allied branches.

PEO 3: Widen talents of student in the field of manufacturing industries, in not only getting employment but also in establishing the industries.

PEO 4: Education of the student for the development of lifelong learning attitudes, ethics and value that will help their careers in engineering, academia, defense, state and central government employments.

MAPPING OF PEOs TO DEPARTMENT MISSION

Program Educational Outcomes	M1	M2	M3	M4
PEO1	3	2	3	1
PEO 2	2	1	3	1
PEO 3	3	2	2	3
PEO 4	2	2	3	3

Program Outcomes (POs)

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex Mechanical engineering problems

2. Problem analysis: Identify, formulate, review research literature, and analyse complex engineering problems in Mechanical Engineering reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes of Mechanical Engineering that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments in Mechanical Engineering, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities in Mechanical Engineering with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice in Mechanical Engineering.

7. Environment and sustainability: Understand the impact of the professional engineering solutions of mechanical Engineering in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

The following are the program specific outcomes

PSO 1: *Specification, fabrication, testing, operation or documentation of basic mechanical systems/processes.*

PSO 2: *Analysis, design, development and implementation of more advanced mechanical systems or processes.*

NEW HORIZON COLLEGE OF ENGINEERING

Department of Mechanical Engineering

Scheme of Fifth Semester B.E. Program

Sl. No	Course Code	Course	Credit Distribution				Overall Credits	Contact Hours Weekly (Theory)	Contact Hours Weekly (Lab)	Marks		
			L	P	T	S				CIE	SEE	Total
1	MEE51	Machine Theory and Mechanism Design+ Lab	3	2	0	0	5	3	3	75	75	150
2	MEE52	Heat Power Cycles + Lab	3	2	0	0	5	3	3	75	75	150
3	MEE53	Rotor Dynamics+ Lab	3	2	0	0	5	3	3	75	75	150
4	MEE54	Design of Machine Elements 1	3	0	1	0	4	3	0	50	50	100
5	MEE55	Project Management and Entrepreneurship	2	0	0	0	2	3	0	25	25	50
6	MEE56x	Professional Elective- PE1	3	0	0	0	3	3	0	50	50	100
7	MEE57	Mini project phase I	0	1	0	0	1	3	-	25	25	50
TOTAL							25	21	09	375	375	750

Sl. No.	Professional Electives, PE1
MEE561	Mechatronics and Microprocessors
MEE562	Composite Materials
MEE563	Refrigeration and Air conditioning
MEE564	Smart Materials
MEE565	Theory of Elasticity

NEW HORIZON COLLEGE OF ENGINEERING

Department of Mechanical Engineering

Scheme of Sixth Semester B.E. Program

Sl. No	Course Code	Course	Credit Distribution				Overall Credits	Contact Hours Weekly (Theory)	Contact Hours Weekly (Lab)	Marks		
			L	P	T	S				CIE	SEE	Total
1	MEE61	Fundamentals Of Heat Transfer + Lab	2	2	0	0	4	3	3	75	75	150
2	MEE62	Finite Element Methods+ Lab	3	2	0	0	5	3	3	75	75	150
3	MEE63	Design of Machine Elements II	3	0	1	0	4	4	0	50	50	100
4	MEE64	Automation Engineering + Lab	2	2	0	0	4	3	3	75	75	150
5	MEE65x	Professional Elective-PE2	3	0	0	0	3	3	0	50	50	100
6	NHOPX	Open elective**	3	0	0	1	4	4	0	50	50	100
7	MEE67	Mini project phase II	0	1	0	0	1	3	-	25	25	50
		TOTAL					25	23	09	400	400	800

**Scheme and Syllabus for open electives is available separately

LIST OF ELECTIVE SUBJECTS OFFERED

Professional Elective, PE2

MEE651 Non-Conventional Manufacturing Technologies
MEE652 Foundry Technology
MEE653 Agile Manufacturing
MEE654 Conventional and Non- Conventional Energy Resources
MEE655 Industrial Robotics
MEE656 Sustainable Energy Sources

Open elective list

NHOP01 Big data analytics(HP vertica-1)
NHOP02 VM ware virtualization essentials-1
NHOP03 Adobe experience manager-1
NHOP04 Big data analytics(HP vertica-2)
NHOP05 VM ware virtualization essentials-2
NHOP06 Adobe experience manager-2
NHOP07 SAP
NHOP08 Schneider-Industry automation
NHOP09 Cisco-routing and switching-1
NHOP10 Data analytics

FIFTH SEMESTER SYLLABUS

MACHINE THEORY AND MECHANISM DESIGN & LAB

Course Code	MEE51
L: P: T: S	3:2:0:0
Exams Hours	03+03

Credits	05
CIE Marks	50+25
SEE Marks	50+25

COURSE OUTCOMES: at the end of the course, the students will be able to:

MEE51.1	Apply the concepts of kinematics and dynamics to synthesise and analyse planar mechanisms
MEE51.2	Investigate the velocity and acceleration of mechanisms by Analytical and Graphical Methods.
MEE51.3	Develop the Simulations of the Mechanisms using Multi-body dynamics package MSc Adams.
MEE51.4	Realise the applications of Governors based on specific requirements.
MEE51.5	Analyse the Problems involving static and dynamic balancing and develop the solutions for the same using Graphical Method.
MEE51.6	Review the concept of Gyroscopic effect and Visualise the effect of Gyroscopic couple in Different Vehicles.

Mapping of Course outcomes to Program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE51.1	2	-	-	-	-	-	-	-	-	-	-	-	3	3
MEE51.2	-	3	-	2	-	-	-	-	-	-	-	-		3
MEE51.3	-	-	2	-	2	-	-	-	-	-	-	-	3	
MEE51.4	2	-	-	2	-	-	-	-	-	-	-	-	3	
MEE51.5	-	3	-	-	2	-	-	-	-	-	-	-		3
MEE51.6	-	3	2	-	-	-	-	-	-	-	-	-		3

Module No	Contents of Module	Hrs	Cos
1	**Introduction and Mechanisms:** Definitions of Link, kinematic pairs, kinematic chain, mechanism, structure, degrees of freedom, Classification of pairs. Grashoff's Law, Grueler's Criterion, Inversions of four bar chain, single slider chain and double slider chain. Straight line mechanism- Peaucellier's mechanism, Intermittent mechanism- Geneva wheel mechanism, toggles mechanism. Ackerman steering gear mechanism.	8	MEE51.1
	Lab : Mechanism and simulation by MSC ADAMS software		
2	**Velocity and Acceleration Analysis of Mechanisms:** Velocity and acceleration analysis of inversions of four bar mechanism, slider crank mechanism by analytical methods.	9	MEE51.2
	Lab :Graphical Method of determining the velocity and acceleration of the mechanism links by the use of solid edge software		MEE51.3
3	**Balancing of rotating masses:** Balancing of single rotating mass in a single plane. Balancing of several rotating mass in single plane and multiple planes.	9	MEE51.4

	Lab :Balancing of rotating mass by force and couple polygon using Solid edge software. Practical study on the static and dynamic balancing		
4	**Governors:** Introduction, types of governors, Centrifugal Governor, Watt Governor, Porter and Hartnell governor Stability**,** Sensitivity, , lift, Isochronous, Hunting, power& effort and coefficient of insensitiveness Controlling force	**9**	**MEE5 1.5**
	Lab :Determination of sensitivity, controlling force by porter governor		
5	**Gyroscope:** Introduction, Precessional angular motion, gyroscopic couple, Gyroscopic effect of a disc, ship, aero plane, two wheelers and four wheelers.	**9**	**MEE5 1.6**
	Lab :Practical Study on the gyroscopic effect		

TEXT BOOKS:

1. **Theory of machines** by RS Khurmi and JK Gupta S Chand Publishers, 34th Ed, **ISBN**: 9788121925372
2. **Mechanism and Machine Theory** By Ambekar A G, Prentice Hall India Learning Private Limited **ISBN** : 978-81-203-3134-1

REFERENCE BOOKS:

1. **Theory of machines** by Ballaney, Khanna Publishers, 25th Ed, **ISBN**-1397887409122X
2. **Theory of machines** by Sadhu Singh, Pearson Education India, 2006. **ISBN**, 87581279.
3. **Theory of machines** by S.S. Rattan Tata McGraw Hill Publications,4th Ed, **ISBN:**9789351343479
4. **Kinematics of machines** by Srinath M.K., Skyward publishers, 20, **ISBN**-978-93-86442-00-0

Assessment Pattern

CIE (50 Marks - Theory)

Bloom's Category	Tests	Assignments	Quizzes	External participation
Marks	**25**	**10**	**5**	**10**
Remember				
Understand	5			
Apply	5	5	5	5
Analyze	5	5		5
Evaluate	5			
Create				

SEE (50 Marks - Theory)

Bloom's Category	Tests(theory)
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

CIE- for lab

Bloom's Category	Tests	Assignments	Quizzes/Viva
	10	10	5
Remember	2	2	1
Understand	2	2	1
Apply	2	2	
Analyze	2	2	1
Evaluate	2	2	2
Create			

SEE - 25 Marks - Lab

Bloom's Category	Tests(theory)
Remember	5
Understand	5
Apply	5
Analyze	5
Evaluate	5
Create	0

HEAT POWER CYCLES & LAB

Course Code	MEE52
L: P: T: S	3:2:0:0
Exams Hours	03+03

Credits	05
CIE Marks	50+25
SEE Marks	50+25

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

MEE52.1	Apply the theoretical knowledge of internal combustion engines to determine the performance characteristics and draw heat balance sheet of petrol and diesel engines.
MEE52.2	Develop solution for thermodynamic cycles of internal combustion engines by applying laws of thermodynamics.
MEE52.3	Calculate the performance of gas turbines with reheat and regeneration, and discuss the performance of combined cycle power plants.
MEE52.4	Development of enhanced thermal systems as a team by minimizing the constraints which enables the student to have continuous learning
MEE52.5	Perform the preliminary design of the major components or systems of a conventional or alternate power plant for sustainable environment
MEE52.6	Design aeco friendlyroom air conditioner and determine the properties of atmospheric air using the psychrometric chart as a tool.

Mapping of Course outcomes to Program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE52.1	1	1	-	-	-	-	-	-	-	-	-	-	3	-
MEE52.2	1	1	3											1
MEE52.3	1		3	3										1
MEE52.4									2			2	3	
MEE52.5			3	3			3						3	
MEE52.6			3			1	3							1

Module No	Contents of Module	Hrs	Co's
1	**RECIPROCATING INTERNAL COMBUSTION ENGINES**: Concepts of Four-stroke & Two -stroke Engine and **valve timing diagram**, Measurement of air and fuel flow rates, Engine output and efficiency, Engine performance characteristics and factors influencing the same, concepts, problems on Morse test and Heat Balance Sheet, **Concepts of Turbo charger and super charger, Modern developments in IC engines (restricted up to 4 stroke BIOFUELS), Engine emission and legal requirements**. Numerical on performance of IC engine	9	**MEE52.1 MEE52.2**
	Lab: 1. Valve Timing/port opening diagram of an I.C. engine (4 stroke/2 stroke) 2. Performance Tests on I.C. Engines(multi cylinder diesel), Calculations of IP, BP, Thermal efficiencies, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F Ratio heat balance sheet, Morse test for Four stroke Diesel Engine. All the graphs using open source tool.		

2	**HEAT & VAPOUR POWER CYCLES:** , Air standard cycle (Otto, Diesel, Dual) cycles, Derivation on efficiencies of the cycles, Comparison on air standard cycle , Problems on Otto, Diesel, Dual cycles and MEP , concept of Stirling cycle, Rankine cycle, Rankine cycle with superheat , The Enthalpy Entropy chart , Regenerative cycle **,binary vapor cycle, combined cycle ,different steam turbine arrangement**	**9**	**MEE52.3**
	Lab: 1. Planimeter, flash point and fire point(open & closed) 2. Performance Tests on I.C. Engines,(single cylinder diesel) Calculations of IP, BP, Thermal efficiencies, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:FRatio for Four stroke Diesel Engine,		
3	**GAS turbine and jet propulsion :** The practical gas turbine cycle, modification to the basic cycle(with Regenerators and Intercoolers), Derivation on efficiency of Brayton Cycle, Work ratio, Optimum Pressure ratio, Problems on gas turbines. **Nozzle shape critical pressure ratio, Nozzle efficiency, fundamental Problems on nozzle** Jet propulsion, Turbo prop, Turbo jet, **solid propellant and liquid propellant rocket engine,** Ramjet**, Scramjet**	**9**	**MEE52.3** **MEE52.4**
	Lab: 1. Determination of Calorific value of solid, liquid and gaseous fuels 2. Determination of Viscosity of a lubricating oil using Redwoods, Saybolt & Torsion		
4	**REFRIGERATION:** Performance of Reversed Carnot cycle, Vapor compression cycles- Effect of sub cooling and super heating, Refrigerating load, Pressure Enthalpy diagram, Vapor absorption cycles, Gas cycles, Liquefaction of gases, Steam jet refrigeration, **Refrigerants- IUPAC nomenclature, types and applications**, Control of refrigerating capacity and problems.	**9**	**MEE52.5**
	Lab: 1. Performance Test on a Vapour Compression Refrigeration 2. Determination of property values for common refrigerants		
5	**Heating ventilation and air conditioning system:** Psychometric mixtures, specific humidity, Relative humidity, and percentage saturation, Specific Enthalpy, Specific Heat Capacity and Specific volume of moist air, Dry bulb temperatures. Wet bulb temperatures, Dew point temperatures, Construction and use of Psychometric chart, Different Psychrometric process, Air conditioning systems, **design of Cooling towers and its parameters**, Problems on with and without using Psychrometric chart.	**8**	**MEE52.5** **MEE52.6**
	Lab: 1. Performance Test on a Vapour Compression Air – Conditioner 2. Duct design for different air conditioning system		

TEXT BOOKS:

1. **Applied Thermodynamics** By R.K.Rajput , Lakmi Publications Ltd., 2nd Ed, **ISBN:**9789351343479
2. **Basic and Applied Thermodynamics** By P.K.Nag , Tata McGraw-Hill Education, 2nd Ed, **ISBN:**9780070151314

REFERENCE BOOKS:

1. **Applied Thermodynamics for Engineering Technologies** ,Fifth Edition By T.D.EASTOP and A.McCONKEY ,Pearson Education,ISBN13: 9780582091931
2. **Fundamentals of Engineering Thermodynamics** by Moran M. J. and H. N. Shapiro, 8th Edition, ISBN : 978-1-118-82044-5
3. **Thermodynamics: An Engineering Approach** by Cengel Y. A. and Boles M. A, 8th Ed, ISBN:9789339221652
4. **Principles of Refrigeration** by Dossat R. J. and Horan T. J.
5. **Refrigeration and Air-conditioning** by Arora C. P, 3rd Ed, ISBN:9789351340164

CIE (50 Marks - Theory)

Bloom's Category	Tests	Assignments	Quizzes	External participation
Marks	**25**	**10**	**5**	**10**
Remember	5			
Understand	5			
Apply	5	5	5	5
Analyze	5	5		5
Evaluate	5			
Create				

SEE (50 Marks - Theory)

Bloom's Category	Tests(theory)
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

CIE- for lab

Bloom's Category	Tests	Assignments	Quizzes/Viva
	10	10	5
Remember	2	2	1
Understand	2	2	1
Apply	2	2	1
Analyze	2	2	1
Evaluate	2	2	1
Create			

SEE - 25 Marks - Lab

Bloom's Category	Tests(theory)
Remember	5
Understand	5
Apply	5
Analyze	5
Evaluate	5
Create	0

ROTOR DYNAMICS & LAB

Course Code	MEE53
L: P: T: S	3:2:0:0
Exams Hours	03+03

Credits	05
CIE Marks	50+25
SEE Marks	50+25

COURSE OUTCOMES: at the end of the course, the students will be able to:

MEE53.1	Apply basic concepts of Fluid Mechanics to conceptualize working of positive displacement machines and turbo machines
MEE53.2	Analyze energy transfer through graphical and analytical methods in turbo machines
MEE53.3	Determine various equipment sizing / design aspects of turbo machines based on requirement
MEE53.4	Apply appropriate engineering techniques/methods to characterize the steam-based turbo machines and its thermodynamic analysis.
MEE53.5	Engage in independent study as a member of a team and make an effective presentation on the application of suitable turbo machines under / within the specified conditions
MEE53.6	Design and analysis of turbo machines by applying the knowledge to practical engineering problems for better solutions and staying updated with the latest developments.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE53.1	1													3
MEE53.2		2												3
MEE53.3			2											3
MEE53.4					1									3
MEE53.5									1					3
MEE53.6			2	1										3

Module No	Contents of Module	Hrs	Cos
1	**Introduction to Turbo machinery :** **Introduction:** Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification, Unit and specific quantities, model studies. Efficiencies of turbo machines. Problems. **Energy exchange in power generating machines:** Euler's turbine equation, Alternate form of Euler's turbine equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor, Problems.	9	MEE53.1 MEE53.2
	Lab: 1. To determine the impact of jet on hemispherical vanes 2. To determine the impact of jet on Flat plate 3. To determine the impact of jet on inclined surface		

2	**Energy exchange in power absorbing machines:** Radial flow compressors and pumps– general analysis, Expression for degree of reaction, velocity triangles, General analysis of axial flow pumps and compressors, degree of reaction, velocity triangles, Problems. **Centrifugal Pumps:** Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, head capacity relationship, Minimum speed for starting the flow, Net positive suction head, Cavitations, Need for priming. Problems.	**9**	**MEE53.3**
	Lab: 1. To determine the performance characteristics of reciprocating pump 2. To determine the performance characteristics of centrifugal pump		
3	**Centrifugal Compressors:** Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency, surging problems. **Axial flow Compressors**: Expression for pressure ratio developed in a stage, work done factor, efficiencies and stalling. Problems. Steam nozzles:- definition, types of nozzles, steady flow energy equation in nozzles, nozzle efficiency, throat pressure for maximum discharge in nozzle flow or choked flow simple problems on nozzles.	**9**	**MEE53.4**
	Lab: 1. To determine the performance characteristics of multi stage air compressor		
4	**Steam Turbines:** Classification of steam turbines, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multi-stage impulse turbine, expression for maximum utilization factor,	**9**	**MEE53.4**
5	**Hydraulic Turbines:** Classification, Different efficiencies, Pelton turbine – velocity triangles, design parameters, Maximum efficiency. Francis turbine - velocity triangles, design parameters, runner shapes for different blade speeds. Draft tubes- Types and functions. Kaplan and Propeller turbines - velocity triangles, design parameters. Problems.	**8**	**MEE53.5** **MEE53.6**
	Lab: 1. To Find the performance test on Pelton Wheel 2. To Find the performance test on Francis turbine		

TEXT BOOKS:

1. **An Introduction to Energy Conversion**, Volume III, Turbo machinery, **V**. Kadambi and Manohar Prasad, New Age International Publishers, 2nd Ed, **ISBN : 978-81-224-3189-6**

REFERENCE BOOKS:

1. **An Introduction to Energy Conversion**, Volume III, Turbo machinery, **V**. Kadambi and Manohar Prasad, New Age International Publishers, 2nd Ed, **ISBN : 978-81-224-3189-6**
2. **Text Book of Turbomachines,** M. S. Govinde Gowda and A. M. Nagaraj, M. M. Publications, 4Th Ed, 2008.

CIE (50 Marks - Theory)

Bloom's Category	Tests	Assignments	Quizzes	External participation
Marks	**25**	**10**	**5**	**10**
Remember				
Understand	5			
Apply	5	5	5	5
Analyze	5	5		5
Evaluate	5			
Create	5			

SEE (50 Marks - Theory)

Bloom's Category	Tests(theory)
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

CIE- for lab

Bloom's Category	Tests	Assignments	Quizzes/Viva
	10	10	5
Remember	2	2	1
Understand	2	2	1
Apply	2	2	
Analyze	2	2	1
Evaluate	2	1	1
Create		1	1

SEE - 25 Marks - Lab

Bloom's Category	Tests(theory)
Remember	5
Understand	5
Apply	5
Analyze	5
Evaluate	5
Create	0

DESIGN OF MACHINE ELEMENTS-1

Course Code	MEE54
L: P: T: S	3:0:1:0
Exams Hours	03

Credits	04
CIE Marks	50+25
SEE Marks	50+25

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

MEE54.1	understand the basic concepts of stress, strain in uni, bi & amp; tri axial state along with standard codes used in design.
MEE54.2	Design the machine elements to withstand static and impact loading using different theories of failure.
MEE54.3	Design for fatigue strength by considering stress concentration into account and design of shafts under fluctuating loads.
MEE54.4	Design the threaded fastener and power screws to withstand parallel and perpendicular loads for both circular and rectangular base plates.
MEE54.5	Design different types of joints, keys, couplings and different gears using design data handbook.
MEE54.6	Design permanent joints like welded and riveted joints for both longitudinal and circumferential joints

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE54.1	3													3
MEE54.2	3	2	3											3
MEE54.3	3	2		2										3
MEE54.4	3		3	2										3
MEE54.5	3		3				2							3
MEE54.6	3									1				3

Module No	Contents of Module	Hrs	Cos
1	**Static and Impact strength, Modes and theories of failure:** Introduction to normal, shear, biaxial and tri axial stresses, Stress tensor, Codes and Standards (only theory) Numerical on Principal Stresses (2D only). **Static strength:** Numerical on Axial load, Bending load and Torsion load. **Impact Strength:** Derivation of instantaneous stress due to axial impact and numerical, effect of inertia. **Modes and Theories of Failure:** Modes of Failure: Fatigue, creep, Ductile, Brittle, Wear, Corrosion. (Theory), Definition of Maximum normal stress theory, Maximum shear stress theory, Distortion energy theory, Coulomb mohr theory. Numerical on Maximum normal stress theory, Maximum shear stress theory, Distortion energy theory.	9	MEE54.1 MEE54.2

2	**Stress concentration, Fatigue strength, LEFM:** **Stress concentration**: Determination of stress concentration factor. **Fatigue strength design:** Introduction to S-N Diagram and Endurance limit, Fatigue strength under fluctuating stresses (soderberg& Goodman criteria), and stresses due to combined loading and numerical. **Linear Elastic Fracture Mechanics (LEFM):** LEFM concepts, crack tip plastic zone, fracture toughness, fatigue crack growth, Means stress effects, crack life estimation, notches and their effects. (no numerical)	**9**	**MEE54.3**
3	**Design of threaded fastener, riveted joint, welded joint:** **Design of threaded fasteners:** Stresses in threaded fasteners due to initial load and applied load, Numerical on axial load, eccentric load and shear load on threaded fasteners for circular and rectangular brackets. **Design of riveted joints:** Lap joints and butt joints, Design of pressure vessels (Longitudinal and circumference joints), Design of Lozenge joints. **Design of welded joints:** Strength of butt and fillet welds, eccentrically loaded welded joints	**9**	**MEE54.4** **MEE54.6**
4	**Design of Knuckle joint, socket and spigot, power screw:** Design of **Knuckle** joint, **socket and spigot** cotter joint. Design of **power screws**, stresses in power screws, efficiency and self locking	**8**	**MEE54.5**
5	**Design of spur gear and Helical gear**: Definitions, stresses in gear tooth, Lewis equation and form factor, Design for strength, Dynamic load and wear load. Helical Gears: Definitions, formative number of teeth, Design based on strength, dynamic and wear loads.	**9**	**MEE54.5**

DESIGN DATA HANDBOOK:

1. **Design Data Hand Book,** K. Lingaiah, McGraw Hill, 2nd Ed. **ISBN:**9780071074391
2. **Data Hand Book,** K. Mahadevan and Balaveera Reddy, CBS Publication, 4th Ed, **ISBN-13:** 978-8123923154
3. **Design Data Hand Book,** H.G. Patil, I. K. International Publisher, 2011, **ISBN-13:** 978-9380578965

TEXT BOOKS:

1. Shigley**'s Mechanical Engineering Design,** by Richard G Budynas and Keith J Nisbett. McGraw Hill International edition, 9th Edition, **ISBN:** 9780071077835
2. **Design of Machine Elements,** V. B Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 4th Ed. **ISBN:**9789339221126

REFERNCE BOOKS:

1. **Machine Design,** Robert L. Norton, Pearson Education. 5th edition, ISBN13:97801333567
2. **Design of Machine Elements,** M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V. Venkatesh, Pearson Education, 8th edition.
3. **Schaum's Outline of Machine Design, Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 1st edition,** ISBN: **9780070634589**

4. **Machine Design,** A CAD Approach: Andrew D DIMAROGONAS, John Wiley Sons, Inc, 7th edition, ISBN: 978-0-471-31528-5

5. **Mechanical Behaviour of Materials**: Engineering Methods for Deformation Fracture an Fatigue 4\e N E Dowling Pearson, 4th edition.

6. **Metal Fatigue in Engineering R I Stephens**, A Fatemi, R R Stephens and H O Fuchs. John-Wiley. 2nd Ed., ISBN: 978-0-471-51059-8

Assessment Patter

CIE (50 Marks - Theory)

Bloom's Category	Tests	Assignments	Quizzes	External participation
Marks	**25**	**10**	**5**	**10**
Remember	3			
Understand	4			
Apply	7	5	5	5
Analyze	8	5		5
Evaluate	3			
Create				

SEE (50 Marks - Theory)

Bloom's Category	Tests(theory)
Remember	8
Understand	7
Apply	15
Analyze	15
Evaluate	5
Create	

PROJECT MANAGEMENT & ENTREPRENEURSHIP

Course Code	MEE55
L: P: T: S	2:0:0:0
Exams Hours	03

Credits	02
CIE Marks	25
SEE Marks	25

COURSE OUTCOMES: at the end of the course, the students will be able to:

MEE55.1	Apply basic principles of project management for real time projects
MEE55.2	Identify the needs, roles, and responsibilities of a leader for feasible and optimum allocation of projects
MEE55.3	Develop project execution plans for global and virtual projects to meet customer requirements
MEE55.4	Apply appropriate techniques for scheduling and evaluation of projects with interpretation of data using Gantt charts and other monitoring techniques
MEE55.5	Promote entrepreneurship as an individual or as a group by creating awareness on its needs and roles with respect to growth of economic development
MEE55.6	Develop solutions for barriers in Small scale industries

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE55.1	1										3			
MEE55.2		1									3		3	
MEE55.3		1	2			2					3			2
MEE55.4				2	2						3		3	
MEE55.5						2	2		1					
MEE55.6			2			2	2							2

Module No	Contents of Module	Hrs	COs
1	**Basics of Project Management:** Introduction, Definition of project, characteristics of projects, types of projects, need for project management, phases of project life cycle management, project management processes, impact of delays in project completions, roles and responsibilities of project leader, tools and techniques of project management. Project identification process, project initiation, and pre-feasibility study, prioritizing projects, securing and negotiating projects.	9	**MEE55.1** **MEE55.2**
2	**Project Planning and Estimation**: Introduction, developing the project management plan, understanding stake holders, communication planning, project meeting management, communication needs of global and virtual project teams, communication technologies, Constructing Work Breakdown Structures (WBS) – scope planning, scope definition, preparation of cost estimation, evaluation of project profitability.	9	**MEE55.3** **MEE55.4**
3	**Purchasing and Contracting for Projects:** Introduction, Purchase Cycle, Contract Management and Procurement Process. **Scheduling, Co-ordination and Control of Projects**: purpose of a project schedule, historical development, uncertainty in project schedules, different	9	**MEE55.1** **MEE55.4**

	scheduling techniques bar (GANTT) charts, bar charts for combined activities, Project evaluation and review techniques, PERT planning. Project direction communication in a project, Role of MIS in project control, performance control, schedule control, cost control cases.		
4	**Project Progress and Inventory Management**: Project Balanced Scorecard Approach, Internal project, customer, financial issues, Finishing the project: Project Close-out, Steps for closing the project, Project termination, Project follow-up, nature of project inventory, supply and transportation of materials. **Entrepreneur**: Meaning of Entrepreneur; Evolution of the Concept, Functions of an Entrepreneur, Types of Entrepreneur, Entrepreneur - an emerging Class. Concept of Entrepreneurship - Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship - its Barriers.	**9**	**MEE55.1 MEE55.5**
5	**Small Scale Industries**: Definition; Characteristics; Need and rationale; Objectives; Scope; role of SSI in Economic Development. Advantages of SSI Steps to start and SSI - Government policy towards SSI; Different Policies of SSI; Government Support for SSI during 5 year plans. Impact of Liberalization, Privatization, Globalization on SSI Effect of WTO/GATT Supporting Agencies of Government for SSI, Meaning, Nature of support; Objectives; Functions; Types of Help; Ancillary Industry and Tiny Industry	**9**	**MEE55.6**

TEXT BOOKS:

1. Contemporary **Project Management**, Timothy J Kloppenborg, Cengage Learning, 2nd Edition, **ISBN: 97881315187**

2. **Project Management a System approach to Planning Scheduling & Controlling,** Harold Kerzner, CBS Publishers and Distributors.2nd Ed., ISBN: 9788123908670

REFERENCE BOOKS:

1. **Project Management,** Benningston Lawrence, McGraw Hill-1970

2. **Project Management,** A Moder Joseph and Phillips New Yark Van Nostrand, Reinhold.

3. **Management Fundamentals**- Concepts, Application, Skill Development – Robers Lusier– Thomson, **ISBN-13:** 978-1506303277

CIE (25 Marks - Theory) **SEE (25 Marks - Theory)**

Bloom's Category	Tests	Assignments	Quizzes
Marks	**10**	**10**	**5**
Remember	1		
Understand	1		
Apply	3	3	2
Analyze	3	3	2
Evaluate	1	3	1
Create	1	1	

Bloom's Category	Total
Marks – 25	**25**
Remember	2
Understand	3
Apply	8
Analyze	8
Evaluate	2
Create	2

MECHATRONICS AND MICROPROCESSORS

Course Code	MEE561
L: P: T: S	3:0:0:0
Exams Hours	03

Credits	03
CIE Marks	50
SEE Marks	50

COURSE OUTCOMES: at the end of the course, the students will be able to:

MEE561.1	Developing insight into applications of the concepts in Mechatronics and Microprocessors.
MEE561.2	Analyze signal conditioning system, different amplifiers Multiplexers and Data acquisition
MEE561.3	Recognize the need and ability to engage in independent study and life-long learning of technology change in Automotive sector.
MEE561.4	Analysis and development of mechatronics system for the use of engineer and society
MEE561.5	Individual and team work in developing assembly language programs for competence in technologies for applications in multidisciplinary settings.
MEE561.6	Life-long learning through individual and team by integration of mechanical system with microprocessors.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE561.1	3												3	
MEE561.2		2												3
MEE561.3						1						2	3	3
MEE561.4	3		1			1							3	3
MEE561.5	3		1						2					3
MEE561.6	3								2			2	3	3

Module No	Contents of Module	Hrs	Cos
1	**Introduction to Mechatronics Systems:** definitions, multi-disciplinary scenario, origin of mechatronics, engineering system, mechatronics system, Measurement and its elements, control systems open loop and closed loop control system, Their elements and functions, **Microprocessor based controllers**. Program logic controller (PLC).Review of sensors and transducers, classification of sensors and transducers, light sensors, proximity sensors, hall effect sensors.	9	**MEE561.1 MEE561.2**
2	**Signal Conditioning:** Introduction to signal conditioning, necessity, methods, and amplifiers. The operational amplifier, logarithmic amplifiers, instrumentation amplifiers Protection, Filtering, Wheatstone bridge, and Digital signals Multiplexers, Data acquisition, Introduction to Digital system. Processing Pulse-modulation.	9	**MEE561.2**

3	**AUTOMOTIVE TRANSMISSION AND SAFETY SYSTEMS** Transmission control – Autonomous cruise control – Braking control, ABS – Traction control, ESP, ASR – Suspension control – Steering control – Stability control– Parking Assist Systems– Safety Systems, SRS, Blind Spot Avoidance – Auto transmission electronic control, Telematics, Automatic Navigation, Future Challenges	**9**	**MEE561.3**
4	**CASE STUDIES OF MECHATRONIC SYSTEM:** Case studies on data acquisition and Control - thermal cycle fatigue of a ceramic plate - pH control system. Deicing temperature control system - skip control of a CD player - Auto focus Camera. Mechatronics control in automated manufacturing, Case studies on design of mechatronics product - pick and place robot - car park barriers - Barcode reader	**9**	**MEE561.4**
5	**Organization & Programming of Microprocessors:** Introduction to microprocessor and INTEL 8085-Data and Address buses, Instruction set of 8085, programming the 8085, assembly language programming. **Central processing unit of microprocessor:** introduction, timing and control unit, basic concepts- instruction and data flow, system timing, Intel 4004	**9**	**MEE561.5 MEE561.6**

TEXT BOOKS:

1. **Mechatronics,** W. Bolton, Longman, 6th Ed, Pearson Publications, ISBN10: 1292076682
2. **Microprocessor Architecture, Programming and Applications With 8085/8085A,** R.S. Ganokar,
3. "**Mechatronics System Design**", Devdas shetty, Richard A. Kolkm PWS Publishing Company, 2nd Ed, **ISBN-13:** 978-1439061985

REFERENCE BOOKS:

1. Brian Morriss, **"Automated Manufacturing Systems** - Actuators Controls, Sensors and Robotics", McGraw Hill International Edition, 1995.
2. **Mechatronics and Microprocessors,** K. P. Ramchandran, G. K. Vijay Raghavan, M.S. Balasundran, Wiley, 1st Ed, 2009.
3. **Mechatronics - Principles, Concepts and applications** – Nitaigour and Premchand Mahilik - Tata McGraw Hill- 1st Ed, **ISBN:** 9780070483743
4. **Mechatronics Principles & applications**, Godfrey C. Onwubolu, Elsevier., 1st Ed, **ISBN:** 9780750663793
5. **Introduction Mechatronics & Measurement systems**, David.G. Aliciatore & Michael. B. Bihistaned, Tata McGraw Hill, 4th Ed, **ISBN:** 9789339204365

CIE (50 Marks - Theory)

Bloom's Category	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5		
Understand	5		
Apply	15	5	
Analyze		5	10
Evaluate		5	
Create			

SEE (50 Marks - Theory)

Bloom's Category	Tests
Remember	8
Understand	7
Apply	15
Analyze	15
Evaluate	5
Create	

COMPOSITE MATERIALS

Course Code	MEE562
L: P: T: S	3:0:0:0
Exams Hours	03

Credits	03
CIE Marks	50
SEE Marks	50

COURSE OUTCOMES: at the end of the course, the students will be able to:

MEE562.1	Identify the suitability of composite materials for various engineering applications
MEE562.2	Ensure safe and sustainable processing techniques for composite materials
MEE562.3	Apply the modern fabrication technique for enhancement of composite properties
MEE562.4	Examine the micro and macro characteristics of lamina
MEE562.5	Analyze the influence of size, shape and particle distribution in MMC'S
MEE562.6	Develop the suitable composite structure for specific application

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE562.1	3	3											3	
MEE562.2		3					1						3	
MEE562.3	3												3	
MEE562.4				2										3
MEE562.5	3	3		2										3
MEE562.6	3	3	2											3

Module No	Contents of Module	Hrs	COs
1	**Introduction to Composite Materials**: Definition, classification and characteristics of composite Materials – fibrous composites, laminated composites, particulate composites. Reinforcements-Fibers- Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibers **Applications of Composites**: Automobile, Aircrafts, Missiles, Space hardware, Electrical and Electronics, Marine, recreational and sports equipment, future potential of composites.	9	**MEE562.1, MEE562.2**
2	**Fiber Reinforced Plastic Processing**: Layup and curing, fabricating process, open and closed mould process, hand layup techniques; structural laminate bag molding, production procedures for bag molding **Advanced Processing Techniques**: Filament winding, pultrusion, pulforming, thermo - forming, injection, injection molding, liquid molding, blow molding.	9	**MEE562.2**
3	**Fabrication of Composite Structures**: Cutting, machining, drilling, mechanical fasteners and adhesive bonding, joining, computer-aided design and manufacturing, tooling, fabrication equipment. **Characteristics of Fiber Reinforced Lamina:** Fundamentals, Elastic properties of a Lamina, Unidirectional Continuous fibre zero degree	9	**MEE562.3 MEE562.6**

	and angle -ply lamina. Introduction to properties of Laminate and failure theories.		
4	**Metal Matrix Composites**: Reinforcement materials, types, characteristics and selection base metals selection. Need for production MMC's and its application. **Fabrication Process For MMCs**: Powder metallurgy technique, liquid metallurgy technique and secondary processing, special fabrication techniques.	**9**	**MEE562.3** **MEE562.4**
5	**Study Properties of MMC"s**: Physical Mechanical, Wear, machinability and Other Properties. Effect of size, shape and distribution of particulate on properties. **Micro Mechanical Analysis of a Lamina**: Introduction, Evaluation of the four elastic moduli by rule of mixture, Numerical problems. Macro Mechanics of a Lamina: Hooke's law for different types of materials, Number of elastic constants, Two - dimensional relationship of compliance and stiffness matrix.	**9**	**MEE562.5**

TEXT BOOKS:

1. **Composite Science and Engineering**, K. K. Chawla Springer Verlag 1998.
2. **Mechanics of Composite Materials**, Autar K. Kaw CRC Press New York.

REFERENCE BOOKS:

1. **Introduction to Composite Materials**, Hull and Clyne, Cambridge University Press, 2nd Edition, 1990
2. **Mechanics of Composite Materials and Structures**, Madhujit Mukhopadhyay , University Press 2009
3. **Mechanics of Composite Materials**, Robert M. Jones, McGraw Hill Kogakusha Ltd.1998
4. **Principles of Composite Material Mechanics**, Ronald F. Gibron. McGraw Hill international, 1994.
5. **Composite Materials Hand Book**, Meing Schwaitz," McGraw Hill book company.1984

CIE (50 Marks - Theory)

Bloom's Category	Tests	Assignments	qiuz
Marks	**25**	**15**	**10**
Remember	3		
Understand	4	5	5
Apply	8	5	5
Analyze	7	5	
Evaluate	3		
Create			

SEE (50 Marks - Theory)

Bloom's Category	Tests
Remember	5
Understand	5
Apply	20
Analyze	10
Evaluate	5
Create	5

REFRRIGERATAION AND AIR CONDITIONING

Course Code	MEE563
L: P: T: S	3:0:0:0
Exams Hours	03

Credits	03
CIE Marks	50
SEE Marks	50

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

MEE563.1	**Apply basic concepts of Fluid Mechanics and thermodynamics to conceptualize working** of Refrigeration and air conditioning system components.
MEE563.2	**Analyze** refrigeration and air conditioning system performance using standards.
MEE563.3	**Determine various equipment sizing** using psychometry calculation.
MEE563.4	**Apply appropriate engineering techniques/methods** of cooling load calculations for different air conditioning systems based on various applications.
MEE563.5	**Design and analysis of central air conditioning systems** by applying the knowledge to practical engineering problems as transmission and distribution of air.
MEE563.6	**Design and analysis of refrigeration systems** by applying the knowledge to practical engineering problems as cold storage.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P011	PO12	PSO1	PSO2
MEE563.1	**1**													**3**
MEE563.2		**2**												**3**
MEE563.3			**3**											**3**
MEE563.4					**2**									**3**
MEE563.5			**3**	**2**										**3**
MEE563.6			**3**	**2**										**3**

Module No	Contents of Module	Hrs	COs
	Introduction and Methods Of Refrigeration Definition, applications, Ton of refrigeration Ice refrigeration, evaporative refrigeration, air refrigeration, vapor refrigeration, dry ice refrigeration, thermo electric refrigeration, pulse tube refrigeration, thermo acoustic refrigeration. **Gas Cycle Refrigeration:** Introduction, reverse Carnot cycle, Bell Coleman cycle, advantages &disadvantages of gas refrigeration system. Applications to aircraft refrigeration, Analysis of gas refrigeration and Numerical.	**8**	**MEE563.1**
2	**Multi Pressure Vapour Compression Systems: Multi** stage compression, Multi evaporator system, calculation, production of solid carbon dioxide. **Refrigerants and cooling towers** Types of Refrigerants, Comparative study of Ethane and Methane derivatives, selection of Refrigerants, Requirements of Refrigerants. Substitutes of CFC Refrigerants, Mixture Refrigerants-azeotropic mixtures	**10**	**MEE563.2 MEE563.3**
	Types of Cooling towers, Analytical and graphical design procedures, Tower Characteristics Parametric analysis.		

3	**Vapour compression refrigeration equipments.** Compressors: Principle, types of compressors, capacity control. Condensers: Types and construction, Expansion devices: Types- Automatic expansion valve, Thermostatic expansion valves, capillary tube. Sizing Evaporator: Types &construction. **Vapour Absorption System** Common refrigerant absorbent combinations, Binary mixtures, Ammonia Water Absorption system, Actual vapour absorption cycle and its representation on enthalpy. Composition diagram, calculations.	**10**	**MEE56 3.4**
4	**Design Conditions Load Calculations and Applied Psychometrics.** Design Conditions: Outside design conditions, choice of inside conditions, Duct Design–Equal Friction Method , Duct Balancing , Fans & Duct System Characteristics , Fan Arrangement Variable Air Volume systems , Air Handling Units and Fan Coil units. Moist Air properties, use of Psychrometry Chart, Various Psychrometry processes, Air Washer, Adiabatic Saturation. Summer and winter Air conditioning, Types of air conditioning systems. Dynamic Losses , Diffusers ,	**10**	**MEE56 3.5**
5	**Air transmission, distribution and control.** Transmission And Distribution Of Air: Room Air Distribution, Friction loss in ducts, dynamic losses in ducts, Air flow through simple Duct system, Duct design. Controls In Refrigeration And Air Conditioning Equipments: High pressure and low pressure cut out, thermostats, pilot operated solenoid valve, motor controls, bypass control-Damper motor.	**6**	**MEE56 3.6**

TEXT BOOKS:

1. **'Refrigeration and Air-Conditioning'** C. P. Arora, Tata McGraw Hill Publication, 3rd edition, **ISBN:**9789351340164
2. **'Refrigeration and Air-Conditioning'** W. F. Stoecker, Tata McGraw Hill Publication, 2nd edition, 1982.
3. **ASHRAE,** Hand Book, 20

REFERENCE BOOKS:

1. '**Principles of Refrigeration'** Dossat, Pearson-2006.
2. **'Heating, Ventilation and Air Conditioning: Analysis and Design** Faye C. McQuiston, Jerald D. Parker, Jeffrey D. Spitler, Wiley Students edition, 6th edition ,ISBN : 978-0-471-47015-1
3. **Air Conditioning Principles and Systems,** Edward PITA, 4thedition, Pearson, ISBN13: 9780130928726

CIE (50 Marks - Theory)

Bloom's Category	Tests	Assignments	Quizzes	Extra Participation
Marks	**25**	**10**	**5**	10
Remember				
Understand	5			
Apply	5	5	5	5
Analyze	5	5		5
Evaluate	5			
Create	5			

SEE (50 Marks - Theory)

Bloom's Category	Tests
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	10

SMART MATERIALS

Course Code	MEE564
L: P: T: S	3:0:0:0
Exams Hours	03

Credits	03
CIE Marks	50
SEE Marks	50

COURSE OUTCOMES: at the end of the course, the students will be able to:

MEE564.1	Gain the knowledge on the characteristics of materials such as Metals, Polymers and Ceramics.
MEE564.2	Analyze the characteristics of Electro, Magneto Rheological fluids and Chromic materials for various mechanical systems.
MEE564.3	Apply the Electro strictive and Magneto strictive materials in the design of different materials.
MEE564.4	Evaluate the properties of shape memory alloys with other class of materials and Propose its suitability for a range of applications in Mechanical and Bio medical.
MEE564.5	Custom and build the smart materials towards the development of smart composites.
MEE564.6	Select Materials for sensor applications based on required properties.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE564.1	3													
MEE564.2	3	2												3
MEE564.3	3		3	1										3
MEE564.4	3					1	1							
MEE564.5	3		3										1	
MEE564.6	3	2												3

Ratings: 3 for high, 2 for substantial, 1 for low. To be followed in mapping.

Module No	Contents of Module	Hrs	COs
1	**Introduction**: Characteristics of metals, polymers and ceramics. Introduction to smart materials. Classification of smart materials. **Sensing and actuation**: Principles of electromagnetic, acoustics, chemical and mechanical sensing and actuation. Types of sensors and their applications. Compatibility with conventional and advanced materials.	9	**MEE564.1** **MEE564.2**
2	**Shape Memory Alloys**: History of shape memory alloys. Classification of shape memory alloys. NITINOLS – melting, casting and forming of NITINOLS, shape memory and pseudo elasticity. Mechanical and bio medical applications of NITINOL. Vibration control through shape memory alloys.	9	**MEE564.2**
3	**Piezoelectric Materials**: Piezoelectric properties, piezoelectric materials. Making of piezoelectric actuators. Inchworm linear motor and application of piezo - actuators for precision movement control. Piezoresistors as sensors. Magnetostrictive materials. Magnetostrictive actuators.	9	**MEE564.3**

4	**Electro rheological (ER) and magneto rheological (MR) fluids**: Mechanisms and properties, fluid composition and behavior. Applications to clutches, vibration dampers and others. Chromic materials – thermochromic, photochromic, piezochromic materials and their applications.	**9**	**MEE564.4**
5	**Structures**: Principles of drag and turbulence control through smart skins, applications in environment such as aerospace and transportation vehicles, manufacturing, repair and maintainability aspects. **Controls**: Principles of structural acoustic control, distributed, analog and digital feedback controls, Dimensional implications for structural control. **Information Processing**: Neural Network, Data Processing, Data Visualization and Reliability – Principles and Application domains.	**9**	**MEE564.5**

TEXT BOOKS:

1) **Smart Materials and Structures**, M V Gandhi and B S Thompson Chapmen & Hall, London, 1992, Springer ,**ISBN-13:** 978-0412370106
2) **Analysis and Design**, A. V. Srinivasan, „Smart Structures –Cambridge University Press, New York, 2001, (ISBN : 0521650267)

REFERENCE BOOKS:

1) **Smart Materials and Structures**, Banks HT, RC Smith, Y Wang, Massow S A, Wiley – Blackwell, **ISBN-13:** 978-0471970248
2) **An Introduction for Scientists and Engineers**, EsicUdd, Optic Sensors: John Wiley & Sons, NewYork, 1991 (ISBN: 0471830070)

Assessment Pattern

CIE (50 Marks - Theory)

Bloom's Category	Tests	Assignments	Quizzes	Extra Participation
Marks	**25**	**10**	**5**	10
Remember				
Understand	5			
Apply	5	5	5	5
Analyze	5	5		5
Evaluate	5			
Create	5			

SEE (50 Marks - Theory)

Bloom's Category	Tests
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	10

THEORY OF ELASTICITY

Course Code	MEE565
L: P: T: S	3:0:0:0
Exams Hours	03

Credits	03
CIE Marks	50
SEE Marks	50

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

MEE565.1	Understand Generalized Hooke's Law to analytically approach the strength and deformation related problems of various structures.
MEE565.2	Analyze elastic deformation problems for homogeneous isotropic materials and anisotropic materials which are the basis of mechanical engineering design.
MEE565.3	Apply the compatibility equations to solve 2D Static loading problems in Cartesian and polar coordinate systems.
MEE565.4	Visualise the transition to plastic deformation from elastic deformation.
MEE565.5	Evaluate the behavioral effect of temperature on thermo elastic materials
MEE565.6	Understand the general solution to Torsion problems based on St. Venant's Approach.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE565.1	3	3	2											3
MEE565.2	3	3		3										3
MEE565.3	3	3		3										3
MEE565.4	3	3		3										3
MEE565.5	3	3	2	3										3
MEE565.6	3	3		3										3

Ratings: 3 for high, 2 for substantial, 1 for low. To be followed in mapping.

Module No	Contents of Module	Hrs	
1	BASIC EQUATIONS OF ELASTICITY Concept of stress and strain, stress and strain transformation, principal stresses and strain in 3D with their invariants, equilibrium equation, compatibility equation. Generalized Hooke's law, Mohr's circle for 2D analysis of stress and strain, Numerical examples.	9	**MEE 565.1**
2	TWO DIMENSIONAL PROBLEMS IN CARTESIAN COORDINATE SYSTEM Plain stress and plain strain, relation between plain stress and plain strain, Airy's stress functions and Bi-harmonic equation. Problems on Airy's Stress function for bending of a narrow cantilever beam of rectangular cross section under edge load, pin ended beam under uniform load, Numerical examples.	9	**MEE565.2**

3	TWO DIMENSIONAL PROBLEMS IN POLAR COORDINATE SYSTEM Airy's stress functions and Bi-harmonic equation. Problems on Airy's Stress function for Axis-symmetric problems -thick cylinder under uniform internal and / or external pressure(Lame's problem), rotating discs of uniform thickness-solid disk and circular disc with hole, Stress in composite tubes(shrink fit).	9	**MEE565.3**
4	TORSION OF PRISMATIC BARS General solution of the torsion problem (Saint –venant), torsion of circular, elliptic and triangular cross sections. Prandtl's membrane analogy, torsion of thin open sections and thin tubes. Numerical examples.	9	**MEE565.4**
5	Thermal Stresses: Thermo elastic stress strain relationship, Equations of equilibrium Thermal stresses in thin circular discs and in long circular cylinder, sphere. Numerical examples.	8	**MEE565.5**

TEXT BOOKS:

1. Advanced Mechanics of solids, L. S. Srinath, Tata Mc. Graw Hill, 3rd Ed, **ISBN:** 9780070139886

2. **Theory of Elasticity**, S. P. Timoshenko and J. N Gordier, Mc.Graw Hill International, 3rd edition, **ISBN:** 9780070701229

REFERENCES BOOKS:

1. **Theory of Elasticity**, Dr. Sadhu Singh, Khanna Publications, 4th Ed, ISBN: 978-81-7409-060-6

2. Elasticity, Theory, Applications & Numericals, Martin H Sadd, Elsevier. 2009, **ISBN:** 9780123744463

3. **Applied Elasticity**, Sitharam T G, Interline Publishing

4. **Applied Elasticity**, C.T. WANG Sc. D. McGraw Hill Book Co, 1st Ed, **ISBN:**9780070702493

Assessment Pattern

Assessment Pattern

CIE (50 Marks - Theory)

Bloom's Category	Tests	Assignments	Quizzes	Extra Participation
Marks	**25**	**10**	**5**	10
Remember				
Understand	5			
Apply	5	5	5	5
Analyze	5	5		5
Evaluate	5			
Create	5			

SEE (50 Marks - Theory)

Bloom's Category	Tests
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	10

SIXTH SEMESTER SYLLABUS

FUNDAMENTALS OF HEAT TRANSFER & LAB

Course Code	MEE61
L: P: T: S	2:2:0:0
Exams Hours	03+03

Credits	04
CIE Marks	50+25
SEE Marks	50+25

COURSE OUTCOMES: at the end of the course, the students will be able to:

MEE61.1	Apply heat transfer principles to design and evaluate the performance of thermal systems in order to minimize the heat loss
MEE61.2	Formulate the steady state conduction equations for one dimensional heat transfer systems like Fins, Lumped systems and develop the solution for the temperature distributions within the body
MEE61.3	Design and apply the concepts of radiation shield system in preventing harmful radiations in power plants.
MEE61.4	Development of enhanced thermal systems as a team by minimizing the constraints which enables the student to have continuous learning
MEE61.5	Analyze the complex engineering problems in convection heat transfer and also use computational tools to design heat exchangers.
MEE61.6	Design and develop the eco friendly Condensing and heat exchange equipment so as to optimize the heat flow.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE61.1	1	2	-	-	-	-	-	-	-	-	-	-	3	-
MEE61.2		2	3											1
MEE61.3			3			1	1							1
MEE61.4									1			1	3	
MEE61.5			3	2	2								3	
MEE61.6			3			1	1							1

Module No.	Content	Hrs.	CO's
1	**Introduction to Concepts And Definitions:** Modes of heat transfer: Basic laws governing conduction, convection, and radiation heat transfer; Thermal conductivity; convective heat transfer coefficient; radiation heat transfer; combined heat transfer mechanism. Boundary conditions of 1st, 2nd and 3rd kind (Numerical Problems) **Conduction:** Derivation of general three dimensional conduction equation in Cartesian coordinate and its special cases, discussion on 3-D conduction in cylindrical and spherical coordinate systems (No derivation). One dimensional conduction equations in rectangular, cylindrical and spherical coordinates for plane and composite walls. (No	10	**MEE61.1, MEE61.6**

	Derivations only Numerical Problems). Thermal contact resistance (Numerical Problems). Introduction to Insulating materials, types and selecting criteria of insulating material, R value of insulation. Critical thickness of insulation without heat generation (Numerical Problems) **Heat transfer in extended surfaces:** Heat transfer in extended surfaces of uniform rectangular cross-section without heat generation, Long fin, and short fin with insulated tip and without insulated tip and fin connected between two heat sources. Fin efficiency and effectiveness. Numerical Problems		
	Lab: **1. Determination of Thermal Conductivity of a Metal Rod.** **2. Determination of Overall Heat Transfer Coefficient of a Composite wall.** **3. Thermal Analysis of Composite walls using FEM.** **4. Determination of Heat transfer co-efficient, efficiency & Effectiveness on a Metallic fin by Free or Natural convection** **5. Determination of Heat transfer co-efficient, efficiency & Effectiveness on a Metallic fin by Forced convection.**		
2	**Transient Conduction:** Lumped system analysis, Use of Transient temperature charts (Heisler's charts) for transient conduction in slab, long cylinder and sphere; use of transient temperature charts for transient conduction in semi-infinite solids. Numerical Problems. **Concepts And Basic Relations In Boundary Layers:** Principle of heat flow in fluids, heat transfer coefficient, overall heat transfer coefficient, Thermal Boundary layer, general expression for local heat transfer coefficient, Average heat transfer coefficient, Significance of Reynold number, Prandtl number, Grashof Number, Stanton Number, Nusselt number, for internal and external flow (discussion only), Flow inside a duct-velocity boundary layer, hydrodynamic entrance length and hydro dynamically developed flow, flow through tubes (internal flow discussion only). Numerical based on empirical relation given in data handbook. Momentum and Energy equations for hydrodynamic and thermal boundary layer over a flat plate.	8	**MEE61.2, MEE61.6**
	Lab: **1. Experiment on Transient Heat Conduction.** **2. Analysis of 1D and 2D Thermal problems solving Conduction and Convection Boundary conditions(min 4 problems)**		
3	**Free or natural convection:** Application of dimensional analysis for free convection, use of correlations of free convection in vertical, horizontal and inclined flat plates, vertical and horizontal cylinders and spheres, Numerical problems. **Forced Convections:** Applications of dimensional analysis for forced convection. Use of various correlations for hydro dynamically and thermally developed flows inside a duct, use of correlations for flow over a flat plate, over a cylinder and sphere. Numerical problems.	8	**MEE61.3, MEE61.5, MEE61.6**
	Lab: **1. Determination of Heat Transfer Coefficient in a free Convection on a vertical/horizontal tube.** **2. Determination of Heat Transfer Coefficient in a Forced Convention Flow through a Pipe.**		
4	**Radiation Heat Transfer:** Thermal radiation; definitions of various terms used in radiation heat transfer; **Basic Laws:** Stefan-Boltzman law, Kirchoff's law, Planck's law and Wein's displacement law, Lambert's law. Radiation heat exchange between two parallel infinite black surfaces, between two parallel infinite gray surfaces; effect of radiation shield; intensity of radiation and solid angle; radiation heat exchange between two finite surfaces	7	**MEE61.2, MEE61.6**

	configuration factor and view factor. Numerical problems.		
	Lab: **1. Determination of Emissivity of a Surface.** **2. Determination of Stefan Boltzman Constant.**		
5	**Condensation And Boiling:** Types of condensation (discussion only) Nusselt's theory for laminar condensation on a vertical flat surface; use of correlations for condensation on vertical flat surfaces, horizontal tube and horizontal tube banks; Reynolds number for condensate flow; regimes of pool boiling, pool boiling correlations. Numerical problems. **Heat Exchangers:** Classification of heat exchangers; Requirements, Design and selection and practical application of Heat exchangers, Temperature profiles of Heat exchangers. Overall heat transfer coefficient, fouling and fouling factor; LMTD, Effectiveness-NTU methods of analysis of heat exchangers. Numerical problems. Introduction to the concepts of Micro, Nano and PCB type heat exchangers.	11	**MEE61.4, MEE61.6**
	Lab: **1. Determination of heat transfer coefficient in film and drop wise condensation.** **2. Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers**		

TEXT BOOKS:

1. **Engineering Heat & Mass transfer,** Mahesh M Rathor, University Science Press Lakshmi Publications, 3rd Ed, ISBN: 9788131806135
2. **Heat and Mass transfer,** P.K. Nag, Tata McGraw Hill Pub 2011 3rd Edition, **ISBN:** 9780070702530

REFERENCE BOOKS:

1. **Heat transfer, a practical approach,** Yunus A- Cengel Tata McGraw Hill,5th Ed, **ISBN:** 9789339223199
2. **Principles of heat transfer,** Kreith Thomas Learning ,7th Ed, ISBN-13: 978-0495657704
3. **Fundamentals of heat and mass transfer,** Frank P. Incropera and David P. Dewitt, John Wiley and son's, 7th Ed, **ISBN : 978-1-118-37924-0**
4. **Heat transfer-A basic approach,** Ozisik, Tata McGraw Hill 2002.

Assessment Pattern

CIE (50 Marks - Theory)

Bloom's Category	Tests	Assignments	Quizzes	Extra Participation
Marks	**25**	**10**	**5**	10
Remember	5			
Understand	5			
Apply	5	5	5	5
Analyze	5	5		5
Evaluate	5			
Create				

SEE (50 Marks - Theory)

Bloom's Category	Tests
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	10

FINITE ELEMENT METHODS & LAB

Course Code	MEE62
L: P: T: S	3:2:0:0
Exams Hours	03+03

Credits	05
CIE Marks	50+25
SEE Marks	50+25

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

MEE62.1	Apply the concepts of Finite Elements Methods to solve statics and dynamics problems.
MEE62.2	Create finite elements for solving practical mechanics problems using 1-D, 2-D and 3-D geometries.
MEE62.3	Investigate the impact of loads and boundary conditions on various structures like bars, trusses, beams etc.
MEE62.4	Compare the finite element results with Theoretical calculations to establish the appropriate validations.
MEE62.5	Develop the analytical skill of solving complex Structural problems using commercial FEA package like ANSYS.
MEE62.6	Formulate the solutions to dynamics problems using FEM with Eigen values and Eigen vectors.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2
MEE62.1	3	3	3	3										3
MEE62.2	3	3	3	3										3
MEE62.3	3	3	3	3										3
MEE62.4	3	3	3	3										3
MEE62.5	3	3	3	3										3
MEE62.6	3	3	3	3										3

Ratings: 3 for high, 2 for substantial, 1 for low. To be followed in mapping.

Module No	Contents of Module	Hrs	Cos
1	**Introduction to Finite Element Methods:** Engineering Analysis, Basic Concept, Historical background, General and Engineering applications of the FEM, Advantages, Classification, Basic steps, Types of elements based on Geometry, bandwidth, Variation formulations using Rayleigh Ritz method and weighted residual methods. Basic Equations and Potential Energy Functional, **Interpolation Models**: Introduction, Polynomial form of interpolation function, Simplex, Complex, and Multiplex elements, Interpolation polynomial in terms of nodal DOF, Selection of the order of the interpolation polynomial, Convergence requirements, coordinate systems. **LAB:-Introduction to FEA package and modeling stress analysis**	9	MEE 62.1
2	**Derivations and solutions for 1-D Bar Element**: Types, Quadratic element, 2 Noded elements: Strain Displacement matrix, Shape functions and its properties, Strain matrix, Element equations, Types of forces, Assembly Procedure **Displacement Methods**: Definition and derivation of Stiffness matrix, Problems on various boundary conditions, Homogeneous and Non Homogeneous. Properties of a stiffness matrix. **Quadratic element**: Strain– Displacement matrix, element stiffness matrix, Element force vector. Temperature effects. Problems **LAB:-Bars of constant cross section area, tapered cross section area and stepped bar**.	9	MEE 62.2 MEE 62.3

3	**Two-Dimensional Elements-Analysis, Applications and Problems:** Pascal's Triangle, Three-Noded Triangular Element (TRIA 3), Four-Noded Quadrilateral Element (QUAD 4), Shape functions for Higher Order Elements (TRIA 6, QUAD 8). Basic Equations and Potential Energy Functional, Lagrange family. Shape functions for Higher Order Elements; area coordinates Isoparametric representation, Jacobian matrix, Strain-displacement matrix, Element stiffness, force term. Problems	**9**	**MEE 62.4**
	LAB:-Stress analysis of a rectangular plate with a circular hole		
4	**Structural analysis through FEM for Beams and Trusses:** **Beams:** 2-Noded beam element**,** Finite element formulation, load vector-point load, UDL, shear force and bending moment, Deflection equation, shape functions and stiffness matrixes. **Trusses:** Includes study of problems with one, two, three and four bar elements, Equation of truss, stiffness matrix derivation, and assumptions.	**9**	**MEE 62.5**
	LAB:-Problems on Trusses and beams, Simply supported, cantilever, beams with UDL, beams with varying load.		
5	**FEM for Dynamic:** System of springs, Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar element, truss element, quadrilateral element, beam element. Lumped mass matrix, Evaluation of Eigen values and Eigen vectors, Applications to bars, stepped bars, and beams,	**8**	**MEE 62.6**
	LAB:-Dynamic Analysis 1) Fixed – fixed beam for natural frequency determination 2) Bar subjected to forcing function 3) Fixed – fixed beam subjected to forcing function		

TEXT BOOKS:

1. **Chandrupatla T. R**., **"**Introduction to Finite Elements in engineering"- 4th Edition, Pearson, **ISBN-13:** 978-0132162746
2. **Lakshmi Narayana H. V**.,"Finite Elements Analysis"– Procedures in Engineering, Universities Press, **ISBN-13:** 978-83714764

Reference Books:

1. **Rae S. S**. "Finite Elements Method in Engineering"- 4th Edition, Elsevier, **ISBN:** 9780750678285
2. **P.Seshu**, "Textbook of Finite Element Analysis" -PHI, ISBN : 978-81-203-2315-5
3. **J.N.Reddy**,"Finite Element Method"-McGraw-Hill International Edition. 3rd Ed, **ISBN:** 9780070607415
4. **Bathe K. J**. "Finite Elements Procedures"- PHI, ISBN : 978-81-203-1075-9
5. **Cook R. D., et al.**, "Concepts and Application of Finite Element Method" John Wiley & Sons INC 4th edition, ISBN-13: 978-0471356059

CIE (50 Marks - Theory)

Bloom's Category	Tests	Assignments	Quizzes	External participation
Marks	**25**	**10**	**5**	**10**
Remember	5			
Understand	5			
Apply	5	5	5	5
Analyze	5	5		5
Evaluate	5			
Create				

SEE (50 Marks - Theory)

Bloom's Category	Tests(theory)
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

CIE- for lab

Bloom's Category	Tests	Assignments	Quizzes/Viva
	10	10	5
Remember	2	2	1
Understand	2	2	1
Apply	2	2	
Analyze	2	2	1
Evaluate	2	2	2
Create			

SEE - 25 Marks - Lab

Bloom's Category	Tests(theory)
Remember	5
Understand	5
Apply	5
Analyze	5
Evaluate	5
Create	0

DESIGN OF MACHINE ELEMENTS 2

Course Code	MEE63
L: P: T: S	3:0:1:0
Exams Hours	03

Credits	04
CIE Marks	50
SEE Marks	50

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

COURSE OUTCOME	NAME OF THE COURSE OUTCOME: DME 2
MEE63.1	Analyze the stresses induced in the curved beams, cylinder and cylinder heads using design standards
MEE63.2	Design ropes, chains and springs with the aid of design data handbook
MEE63.3	Gain knowledge on surface failures subjected to different types of wear
MEE63.4	Realize the importance of lubricants and their properties toward the design of bearing elements
MEE63.5	Recommend the adequate surface hardness for bevel and worm gears with detailed design subjected to static and dynamic loading conditions
MEE63.6	Design different types of clutches and breaks based on the loading conditions.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE63.1	3	3	3	3										3
MEE63.2	3	3	3	3										3
MEE63.3	3	3	3	3										3
MEE63.4	3	3	3	3										3
MEE63.5	3	3	3	3										3
MEE63.6	3	3	3	3										3

Ratings: 3 for high, 2 for substantial, 1 for low. To be followed in mapping.

Module No	Contents of Module	Hrs	Cos
1	**Curved beams, cylinders and cylinder heads** **Curved Beams**: Stresses in curved beams of standard cross sections used in crane hook, punching presses & clamps, closed rings and links **Cylinders & Cylinder Heads:** Problems on Lame's Equation(no derivation); compound cylinders, stresses due to different types of fits.	10	MEE63.1
2	**Design of Ropes, Chains, Springs and Surface failure** **Design of Ropes, Chains:** Ropes and chains for different applications and numerical. **Design of Springs** :Types of springs - stresses in Helical coil springs of circular and non-circular cross sections. Tension and compression springs, springs under fluctuating loads, Leaf Springs, Stresses in leaf springs, equalized stresses and energy stored in springs. ***Surface failure:*** Introduction, Surface geometry, Mating surface, friction, adhesive wear, abrasive wear, corrosion wear.	10	MEE63.2 MEE63.3
3	**Lubrication and Bearings** **Lubrication and Bearings**: Lubricants and their properties, Mechanisms of Lubrication bearing modulus, coefficient of friction, minimum oil film thickness, Heat Generated, Heat dissipated, Bearing Materials, Examples of journal bearing and design.	8	MEE63.4

4	**Bevel and Worm Gears** **Bevel Gears**: Definitions, formative number of teeth, Design based on strength, dynamic and wear loads. **Worm Gears**: Definitions, Design based on strength, dynamic, wear loads and efficiency of worm gear drives.	8	**MEE63.5**
5	**Design of Clutches and Brakes** **Design of Clutches:** Single plate, multi plate clutches (problems only). **Design of Brakes:** Block and Band brakes, self locking of brakes, Heat generation in Brakes.	8	**MEE63.6**

DESIGN DATA HANDBOOK:

1. Design Data Hand Book, K. Lingaiah, seventh edition SUMA PUBLISHERS 2006.
2. Data Hand Book, K. Mahadevan and Balaveera Reddy, CBS Publication.
3. Design Data Hand Book, H.G. Patil, I. K. International Publisher, 2010.

TEXT BOOKS:

1. Mechanical Engineering Design, Joseph E Shigley and Charles R.Mischke. McGraw Hill International edition, 10th edition 2015, ISBN-10: 933922163X.
2. Design of Machine Elements, V. B Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, Fourth Edition January 2016, ISBN-13: 978-9339221126

REFERNCE BOOKS:

1. Machine Design, Robert L. Norton, 3rd edition 2006 Pearson Education Asia, ISBN 0-13-148312-9.
2. Design of Machine Elements, M. F. Spotts, T. E. Shoup, L. E.Hornberger, S. R. Jayram and C. V. Venkatesh, Pearson Education, 2006 ISBN-0130489891.
3. Machine Design, Hall, Holowenko, and Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 2008.
4. Machine Design, A CAD Approach: Andrew D DIMAROGONAS, John Wiley Sons, Inc, 2001, ISBN 0-471-31528-1.

CIE (50 Marks - Theory)

Bloom's Category	Tests	Assignments	Quizzes	External participation
Marks	**25**	**10**	**5**	**10**
Remember	5			
Understand	5			
Apply	5	5	5	5
Analyze	5	5		5
Evaluate	5			
Create				

SEE (50 Marks - Theory)

Bloom's Category	Tests(theory)
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

AUTOMATION ENGINEERING & LAB

Course Code	MEE64
L: P: T: S	2:2:0:0
Exams Hours	03+03

Credits	04
CIE Marks	50+25
SEE Marks	50+25

COURSE OUTCOMES: at the end of the course, the students will be able to:

MEE64.1	Apply the knowledge of automation and production concepts in manufacturing and assembly of parts/products
MEE64.2	Analyze the appropriate technologies to meet the demand for application of industrial automation systems
MEE64.3	Design the solutions for line balancing in manufacturing industries to reduce cycle time
MEE64.4	Apply appropriate inspection techniques with modern engineering tools for analysis of automated assembly systems and automated guided vehicle
MEE64.5	Create bill of materials, material master, purchase order etc using SAP ERP software and simulate the part program by means of CNC software
MEE64.6	Design and develop the various configuration of robots by using programming skills

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE64.1	3												3	
MEE64.2	3	3											3	3
MEE64.3		3	1											3
MEE64.4	3				3								3	3
MEE64.5	3				3							2		3
MEE64.6	3	3		1										3

Ratings: 3 for high, 2 for substantial, 1 for low. To be followed in mapping.

Module No.	Contents of Module	Hrs	Cos
1	**Computer Integrated Manufacturing Systems:** Introduction, Automation definition, Types of Automation, Reasons or Advantages of Automation, Disadvantages of Automation, Automation Strategies, Types of Production Systems, CIM, Information Processing Cycle in Manufacturing, Production concepts, Mathematical Models-Manufacturing Lead Time, Production Rate, Components Of Operation Production Time, Production Capacity, Utilization And Availability, Work-In-Process, WIP Ratio, TIP Ratio, Problems Using Mathematical Model Equations. **High Volume Production System:** Introduction, Automated Flow Line Symbols, Objectives, Work Part Transport- Continuous, Intermittent/ Asynchronous , Synchronous, Pallet Fixtures & Work Piece Holding Devices, Transfer Mechanism- Linear-Walking Beam, Roller Chain Drive, Rotary-Rack And Pinion, Rachet & Pawl, Geneva Wheel, Buffer Storage, Control Functions-Sequence, Safety, Quality, Automation For Machining Operation.	09	MEE64.1 MEE64.2
	Lab: CNC Milling (Absolute Programming), CNC Milling (Incremental Programming)		

2	**Analysis Of Automated Flow Line & Line Balancing:** General Terminology and Analysis, Analysis of Transfer Line without Storage Upper Bound Approach, Lower Bound Approach And Problems, Analysis of Transfer Lines with Storage Buffer, Effect of Storage, Buffer Capacity with Simple Problem, Partial Automation-With Numerical Problems, Flow Lines with more than Two Stages, Manual Assembly Lines, Line Balancing Problem.	**09**	**MEE64.2 MEE64.3**
	Lab: CNC Turning with Facing, Tapering and slotting operations		
3	**Minimum Rational Work Element:** Work Station Process Time, Cycle Time, Precedence Constraints. Precedence Diagram, Balance Delay Methods of Line Balancing-Largest Candidate Rule, Kilbridge And Westers Method, Ranked Positional Weight Method, Numerical Problems Covering All Above Methods And Computerized Line Balancing.	**09**	**MEE64.2 MEE64.3 MEE64.4**
	Lab: Case study on Material Management(MM) module using SAP		
4	**Automated Assembly Systems:** Design for Automated Assembly Systems, Types of Automated Assembly System, Parts Feeding Devices-Elements of Parts Delivery System-Hopper, Part Feeder, Selectors, Feedback, Escapement and Placement, Analysis of Single Station Assembly System. (Multi-Station Analysis) **Automated Guided Vehicle System:** Introduction, Vehicle guidance and routing, System Management, Applications of AGV's, Quantitative Analysis of AGV's with Numerical Problems.	**08**	**MEE64.2 MEE64.4 MEE64.5**
	Lab: Case study on Production Planning (PP) module using SAP		
5	**Computerized Manufacturing Planning System:** Introduction, Computer Aided Process Planning, Retrieval types of process planning, Generative type of process planning, Material requirement Planning, Fundamental Concepts of MRP, Inputs to MRP, Capacity planning. **Robotics:** Introduction, Anatomy of Robot, Robot Configurations, Robot Motions, Robot Programming Methods, Robot Programming Languages, End effectors- Grippers & Tools, Robot Sensors and Robot applications.	**09**	**MEE64.4 MEE64.6**
	Lab: Demonstration and Working on CNC Milling & Turning machine		

TEXT BOOKS:

1. **Automation, Production System & Computer Integrated Manufacturing,** M. P. Groover, Person India, 4th Ed, **ISBN-13:** 978-9332572492

2. **Principles of Computer Integrated Manufacturing**, S. Kant, Vajpayee, Prentice Hall India, ISBN: 978-81-203-1476-4

REFERENCE BOOKS:

1. **Computer Integrated Manufacturing**, J. A. Rehg & Henry. W. Kraebber. Not listed in site

2. **CAD/CAM: Theory and Practice** by Zeid, Tata McGraw Hill, **And ISBN:** 9780070151345

Assessment Pattern

CIE (50 Marks - Theory)

Bloom's Category	Tests	Assignments	Quizzes	External participation
Marks	**25**	**10**	**5**	**10**
Remember				
Understand	5			
Apply	5	5	5	5
Analyze	5	5		5
Evaluate	5			
Create	5			

SEE (50 Marks - Theory)

Bloom's Category	Tests(theory)
Remember	15
Understand	15
Apply	10
Analyze	5
Evaluate	5
Create	

CIE- for lab

Bloom's Category	Tests	Assignments	Quizzes/Viva
	10	10	5
Remember	2	2	1
Understand	2	2	1
Apply	2	2	
Analyze	2	2	1
Evaluate	2	1	1
Create		1	1

SEE - 25 Marks - Lab

Bloom's Category	Tests(theory)
Remember	5
Understand	5
Apply	5
Analyze	5
Evaluate	5
Create	

NON-CONVENTIONAL MANUFACTURING TECHNOLOGIES

Course Code	MEE651
L: P: T: S	3:0:0:0
Exams Hours	03

Credits	03
CIE Marks	50
SEE Marks	50

COURSE OUTCOMES: at the end of the course, the students will be able to:

MEE651.1	Analyze the working of conventional thermal power plant to optimize the output from them
MEE651.2	Apply the knowledge to solve technical problems related to boiler operations and accessories.
MEE651.3	Evaluate a wide range of potential solution pertaining to the working of a Hydel Power Plant.
MEE651.4	Apply independent judgement to come up with solutions to improve the conversion ratio of renewable energy sources like solar and wind.
MEE651.5	Understand and Apply the knowledge to ensure a safe working environment for a Nuclear Power Plant and Fuel Cells.
MEE651.6	To develop effective methods for low cost power generation using biomass.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO11	PSO1	PSO2
MEE651.1	3												3	
MEE651.2	3	3											3	
MEE651.3	3	3											3	
MEE651.4	3												3	
MEE651.5	3												3	
MEE651.6	3	3											3	

Ratings: 3 for high, 2 for substantial, 1 for low. To be followed in mapping.

Module No	Contents of Module	Hrs	Cos
1	**Introduction:** History, Classification, Need, process selection, comparison between conventional and un-conventional manufacturing Techniques. **Ultrasonic Machining (USM):** Introduction, Principal, equipment, Process characteristics, Functions and Characteristics of Abrasive Slurry, Tool Feed System and Its Functions, Transducer, Effect of parameter, Advantages, Limitations and Application.	**8**	**MEE651.1 MEE651.2 MEE651.3 MEE651.5 MEE651.6**
2	**Abrasive Jet Machining (AJM):** Introduction, Principal, Equipment, Process characteristics, Variables in AJM, Advantages, Limitations and Application. **Water Jet Machining (WJM):** Introduction, Principal, Equipment, Advantages, Limitations and Application. **Abrasive Water Jet Machining (AWJM):** Introduction, Principal, Equipment, Advantages, Limitations and Application.	**9**	**MEE651.2 MEE651.3 MEE651.4 MEE651.6**

3	**Electrochemical Machining (ECM):** Introduction, Equipment, Process characteristics, Tooling, Advantages, Limitations and Application. Electrochemical Shaping, turning, Grinding, Honing, deburring. **Chemical Machining (CHM):** Introduction, elements of process, chemical blanking process, chemical milling, process steps –masking, Etching, process characteristics of CHM, Advantages, Limitations and Application.	**9**	**MEE651.2 MEE651.3 MEE651.4 MEE651.6**
4	**Electrical Discharge Machining (EDM):** Introduction, Principal, Equipment, Process characteristics, spark generator, Types, Functions and Properties of Dielectric Fluid, Multi Lead EDM, Types And Requirements Of Electrodes. Factors Affecting Electrode Wear, Electrode feed control, Flushing, accessories, Advantages, Limitations and Application., electrical discharge grinding, Traveling wire EDM **Ion Beam Machining (IBM):** Introduction, Principle, Equipment, Advantages, Limitations and Application.	**9**	**MEE651.2 MEE651.3 MEE651.4 MEE651.6**
5	**Plasma Arc Machining (PAM):** Introduction, Principal, Equipment, Process characteristics selection of gas, Safety precautions, Plasma Torch, Generation of Plasma Torch, Advantages, Limitations and Application. **Laser Beam Machining (LBM):** Introduction, Principal, Equipment, Process characteristics, and parameters, Advantages, Limitations and Application. **Electron Beam Machining (EBM):** Introduction, Principle, Equipment, Process characteristics Advantages, Limitations and Application.	**9**	**MEE651.2 MEE651.3 MEE651.4 MEE651.6**

TEXT BOOKS:

1. Modern machining process, Pandey and Shan, Tata McGraw Hill ,1st Ed, **ISBN:**9780070965539
2. Production Technology, HMT Tata McGraw Hill, 1st Ed, **ISBN:** 9780070964433

REFERENCE BOOKS:

1. Non-Conventional Machining, P.K.Mishra, Narosa Publishing House, **and ISBN-13:** 978-8319138
2. Nontraditional manufacturing Processes, Gary F Benedict, CRC press, 1st Ed, **ISBN-13:** 978-0824773526
3. Advanced methods of Machining, J.A.McGeough, Chapman and Hall, ISBN: 9788184898453
4. Metals Handbook: Machining Volume 16, Joseph R. Davis (Editor), American Society of Metals (ASM) ISBN-13:978-08700223 ISBN-10:08700220

Assessment Pattern

CIE (50 Marks - Theory)

Bloom's Category	Tests	Assignments	Quizzes	External participation
Marks	**25**	**10**	**5**	**10**
Remember				
Understand	5			
Apply	5	5	5	5
Analyze	5	5		5
Evaluate	5			
Create	5			

SEE (50 Marks - Theory)

Bloom's Category	Tests(theory)
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

FOUNDRY TECHNOLOGY

Course Code	MEE652
L: P: T: S	3:0:0:0
Exams Hours	03

Credits	03
CIE Marks	50
SEE Marks	50

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

MEE652.1	Understand special casting techniques
MEE652.2	Design and develop the conventional foundries
MEE652.3	Analyze casting defects, special moulding techniques
MEE652.4	Understand Foundry metallurgy & Design gating system
MEE652.5	Evaluate the fettling processes, patterns and mould making
MEE652.6	Apply modern tools to develop casting aids

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO11	PSO1	PSO2
MEE652.1	3												3	
MEE652.2	3	3											3	
MEE652.3	3	3											3	
MEE652.4	3												3	
MEE652.5	3												3	
MEE652.6	3	3											3	

Ratings: 3 for high, 2 for substantial, 1 for low. To be followed in mapping.

Module No	Contents of Module	Hrs	Cos
1	**INTRODUCTION:** Introduction to casting process and its potential, Chronology of the art of founding, freezing of molten metal's /alloys, grain structure and effect of heat transfer on grain structure and properties **FOUNDRY METALLURGY:** Oxidation of liquid metals, gas dissolution in liquid metals, methods of degassing, fluidity, factors affecting fluidity, fluidity tests, hot tearing, shrinkage of liquid metals.	**9**	**MEE652.1 MEE652.2**
2	**PATTERN AND MOULD MAKING:** Pattern - types and materials mould and mould materials, popular casting processes, core and core making, importance of pattern and core on quality and economy of the castings **CUPOLA MELTING:** Developments in cupola melting – hot blast cupola, water cooled cupola, balanced blast cupola, cokeless cupola, cupola charge calculations.	**9**	**MEE652.1 MEE652.5**
3	**SOLIDIFICATION OF CASTINGS:** Crystallization and development of cast structure-nucleation, growth. Feeding of metals / alloys, design of feeder, Chvorinov's rule, casting defects, remedies, Fettling and NDT of castings. **CASTING DESIGN:** Introduction to casting design, redesign considerations, design for minimum casting stresses, design for directional solidification, design for metal flow, safety factors, design for low pattern cost and model making as an aid in design.	**9**	**MEE652.2 MEE652.3 MEE652.5**

4	**ALLOYS HANDLED BY FOUNDRIES:** Discussion on foundry practices for cast iron, steel, malleable iron, SG iron and zinc alloys, copper alloys and aluminum alloys with applications. **SPECIAL MOULDING TECHNIQUES:** Principles, materials used process details and application of no-bake sand systems, vacuum moulding, flask less moulding, and high pressure moulding.	**9**	**MEE652.1 MEE652.3**
5	**MELTING OF ALLOYS AND GATING:** Melting practices, selection of furnaces, pouring methods, flow of molten metal inside the mould, design of gates and types of gates. A case study using CAD/CAE/CAM(RP) for developing pattern and core box for casting	**8**	**MEE652.4 MEE652.6**

TEXT BOOKS:

1. Heine R W, Loper C R and Rosenthal P C, "Principles of Metal Casting", Tata McGraw Hill, New Delhi,2nd Ed, **ISBN:** 9780070993488
2. John Campbell, "Castings", Butterworth Heinemann, Oxford,2nd Ed, ISBN-13: 978-0750647908f

REFERENCES:

1. Jain P L, "Principles of Foundry Technology", Tata McGraw Hill, New Delhi,5th Ed, **ISBN:** 9780070151291
2. Elliot R, "Cast Iron Technology", Jaico Publications, 2009.
3. Tiwari, "Cast Iron Technology", CBS Publications, 2007, ISBN: 9788123914893
4. ASM Metals Handbook - Castings, Vole .15, ASM Int. Metals Park, OHIO, 2008.

Assessment Pattern

CIE (50 Marks - Theory)

Bloom's Category	Tests	Assignments	Quizzes	External participation
Marks	**25**	**10**	**5**	**10**
Remember				
Understand	5			
Apply	5	5	5	5
Analyze	5	5		5
Evaluate	5			
Create	5			

SEE (50 Marks - Theory)

Bloom's Category	Tests(theory)
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

AGILE MANUFACTURING

Course Code	MEE653
L: P: T: S	3:0:0:0
Exams Hours	03

Credits	03
CIE Marks	50
SEE Marks	50

Course Outcomes: At the end of the Course, the student will be able to:

MEE653.1	Understand and develop the concepts of Agile Manufacturing.
MEE653.2	Analyze the Product/Process development and its application in Agile Manufacturing.
MEE653.3	Understand Supply Chain Management and its link with Agile Manufacturing.
MEE653.4	Apply the Computer Control in Agile Manufacturing.
MEE653.5	Apply Corporate Knowledge of Management in Agile Manufacturing.
MEE653.6	Understand the Skill & Knowledge in Agile Manufacturing.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO11	PSO1	PSO2
MEE653.1	3												3	
MEE653.2	3												3	
MEE653.3	3												3	
MEE653.4	3												3	
MEE653.5	3												3	
MEE653.6	3												3	

Ratings: 3 for high, 2 for substantial, 1 for low. To be followed in mapping.

Module No	Module Contents	Hrs	Cos
1	**Agile Manufacturing:** Definition, business need, conceptual framework, characteristics, generic features. **Developing Agile Manufacturing:** Enterprise, Strategies, integration of organization, workforce and technology, reference models, examples.	08	**MEE653.1** **MEE653.2**
2	**Integration Of Product /Process Development:** Principles, Robust design approach, Approaches to enhance ability in manufacturing, Role of QFD, Managing people in Agile organization, Approaches. **Application Of It/Is Concepts In Agile Manufacturing:** Strategies, Management of complexities and information. Flow approaches, applications of multimedia to improve agility in manufacturing, system concepts.	10	**MEE653.1** **MEE653.3**
3	**Agile Supply Chain Management:** Principles, IT/IS concepts in supply chain management, enterprise integration and management in agile manufacturing, concepts, Agility, Adaptability and Leanness – comparison of concepts.	08	**MEE653.1** **MEE653.4**
4	**Computer Control Of Agile Manufacturing:** CAPP for Agile Manufacturing, Aggregate capacity planning and production line design / redesign in Agile manufacturing, Cellular manufacturing, concepts, and	08	**MEE653.3** **MEE653.5**

5	**Corporate Knowledge Management In Agile Manufacturing:** Strategies, strategic options in Agile manufacturing, Role of standards. **Design Of Skill & Knowledge**: Enhancing technology for Machine tool system, Resumption of design requirement geometry, definition, methods, decision support for selection of cutting parameters, design enhancements. (parametric approach only)	10	**MEE653.4** **MEE653.6**

TEXT BOOKS:

1. **Agile Manufacturing -Forging new Frontiers -** Paul T. Kidd - Addison Wesley- Publication Amagow Co. UK, ISBN-13: 978-0201631630

2. **Agile Manufacturing",** A Gunasekharan, the 21st Century Competitive strategy, **ISBN:** 9780080435671, Elsevier Press, India

3. Agile Manufacturing -Proceeding of International Conference on Agile Manufacturing Dr. M.P Chowdiah (Editor), TATA McGraw Hill Publications 2014, **ASIN:** B01NBY3E8K

REFERENCE BOOKS:

1. **Concurrent Engg -** Paul T Kidd – Addison Wesley Publication -2014. Not listed

2. **World Class manufacturing -** Paul T Kidd – Addition Wesley Pub – 2014. Not listed

3. O Levine Transitions to Agile Manufacturing-Joseph C Moutigomery and Lawrurence – Staying Flexible for competitive advantage, ASQC quality press, Milwaukee, Wisconsin, USA, **ISBN-13: 978-0873893473**

4. **Agile Development for Mass Customization-**David M Anderson and B Joseph Pine, Irwin Professional Publishing, Chicago, USA, **ISBN-13:** 978-07863150

Assessment Pattern

CIE (50 Marks - Theory)

Bloom's Category	Tests	Assignments	Quizzes	External participation
Marks	**25**	**10**	**5**	**10**
Remember				
Understand	5			
Apply	5	5	5	5
Analyze	5	5		5
Evaluate	5			
Create	5			

SEE (100 Marks - Theory)

Bloom's Category	Tests(theory)
Remember	30
Understand	30
Apply	20
Analyze	10
Evaluate	10
Create	

CONVENTIONAL AND NON-CONVENTIONAL ENERGY RESOURCES

Course Code	MEE654
L: P: T: S	3:0:0:0
Exams Hours	03

Credits	03
CIE Marks	50
SEE Marks	50

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

MEE654.1	Acquire in-depth knowledge of renewable energy sources and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge pool.
MEE654.2	Analyze complex engineering problems critically pertaining to design of system build to harness useful work from renewable energy sources.
MEE654.3	Apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.
MEE654.4	Evaluate a wide range of potential solutions for design related problems and arrive at feasible, optima solutions after considering public health and safety, cultural, societal and environmental factors.
MEE654.5	Extract information through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, contribute individually/in group(s) to the development of scientific/technological knowledge in one o more domains of renewable energy.
MEE654.6	To develop workplace skills that can meet industry requirements, by imparting theoretical knowledge and practical training in Renewable Energy resources and technologies.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE654.1	3	3	3	3								2	3	
MEE654.2	3	3	3	3									3	
MEE654.3	3	3	3	3									3	
MEE654.4	3	3	3	3		2	2	2					3	
MEE654.5	3	3	3	3	2				2	2		2	3	
MEE654.6	3	3	3	3	2								3	

Ratings: 3 for high, 2 for substantial, 1 for low. To be followed in mapping

Module No	Contents of Module	Hrs	Cos
1	**Steam Power Plant:** Layout of steam power plant, Different Types of Fuels used for steam generation, Equipment for burning coal in lump form, strokers, different types, Advantages and Disadvantages of using pulverized fuel, Equipment for preparation and burning of pulverized coal, unit system and bin system. Pulverized fuel furnaces, cyclone furnace. **A Brief Account Of Benson, Velox, Schmidt Steam Generators**. Chimneys: Natural, forced, induced and balanced draft. Cooling towers and Ponds. Accessories for the Steam generators such as Super heaters, De-super heater, control of super heaters, Economizers, Air pre heaters and re-heaters.	**9**	**MEE654.1 MEE654.**

2	**Diesel Engine Power Plant:** Applications of Diesel Engines in Power field. Method of starting Diesel engines. Auxiliaries like cooling and lubrication system, intake and exhaust system, Layout of diesel power plant. **Hydro-Electric Plants**: Hydrographs, flow duration and mass curves, unit hydrograph and numerical. Storage and pondage, pumped storage plants, low, medium and high head plants, Penstock, water hammer, surge tanks, gates and valves. General layout of hydel power plants.	**9**	**MEE65 4.2**

3	**Solar Energy:** Solar Extra terrestrial radiation and radiation at the earth surface, radiation-measuring instruments, working principles of solar flat plate collectors, solar pond and photovoltaic conversion (Numerical Examples). **Wind Energy**: Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis wind mills.		**MEE654.2 MEE654.3**
4	**Nuclear Power Plant**: Principles of release of nuclear energy; Fusion and fission reactions. Nuclear fuels used in the reactors. Elements of the nuclear reactor; moderator, control rod, fuel rods, coolants. Brief description of reactors of the following types-Pressurized water reactor, Boiling water reactor, Sodium graphite reactor and gas cooled reactor, Radiation hazards, Shieldings, Radio-active waste disposal. **Hydrogen Energy** : Properties of Hydrogen with respected to its utilization as a renewable form of energy, sources of hydrogen, production of hydrogen, electrolysis of water, thermal decomposition of water, thermo chemical production, bio-chemical production.	**9**	**MEE654.3 MEE654.4**
5	**Geothermal Energy Conversion**: Principle of working, types of geothermal station with schematic diagram, problems associated with geothermal conversion, scope of geothermal energy. **Tidal Power**: fundamental characteristics of tidal power, harnessing tidal energy, limitations. **Ocean Thermal Energy Conversion**: Principle of working, Rankine cycle, problems associated with OTEC. **Energy from Bio Mass**: Photosynthesis, photosynthetic oxygen production, energy plantation, bio gas production from organic wastes by anaerobic fermentation, description of bio-gas plants, problems involved with bio-gas production.	**9**	**MEE654.4 MEE654.5**

TEXT BOOKS:

1. Non-Conventional Energy Sources by *G.D Rai K*, Khanna Publishers,5th Ed, ISBN: 97881-7409-073-8
2. Solar energy, by *Subhas P Sukhatme*– Tata McGraw Hill, 3rd Ed, **ISBN:** 9780070260641
3. **Power Plant Engineering**, P. K. Nag Tata McGraw Hill ,4th Ed, **ISBN:** 9789339204044
4. **Power Plant Engineering,** Domakundawar, Dhanpath Rai sons.

REFERENCE BOOKS:

1. **Power Plant Engineering,** R. K. Rajput, Laxmi publication, 5th Ed, ISBN: 9788131802557
2. **Principles of Energy conversion**, A. W. Culp Jr., McGraw Hill, 2nd Ed, **ISBN-13:** 978-0070435599
3. Renewable Energy Sources and Conversion Technology by *N.K.Bansal, Manfred Kleeman & Mechael Meliss*, Tata McGraw Hill, 2001.

Assessment Pattern

CIE (50 Marks - Theory)

Bloom's Category	Tests	Assignments	Quizzes	External participation
Marks	**25**	**10**	**5**	**10**
Remember				
Understand	5			
Apply	5	5	5	5
Analyze	5	5		5
Evaluate	5			
Create	5			

SEE (100 Marks - Theory)

Bloom's Category	Tests(theory)
Remember	30
Understand	30
Apply	20
Analyze	10
Evaluate	10
Create	

INDUSTRIAL ROBOTICS

Course Code	MEE655
L: P: T: S	3:0:0:0
Exams Hours	03

Credits	03
CIE Marks	50
SEE Marks	50

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

MEE655.1	Apply the knowledge of robotics in different industries and other engineering applications
MEE655.2	Identify the robot drives and evaluate the control system for robot components in practical cases for safety purpose
MEE655.3	Analyze the robotic dynamics and configuration of robot used in industries for desired engineering applications
MEE655.4	Select the appropriate sensors used in robots for various applications.
MEE655.5	Apply the appropriate programming techniques along with its simulation for executing of operations in complex environments
MEE655.6	Design and develop the robots with different configurations to perform new tasks for industrial applications.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE655.1	3	3											2	
MEE655.2	3	3	3										2	
MEE655.3		3	3		3									
MEE655.4	3	3	3		3									3
MEE655.5	3	3	3											3
MEE655.6			3		3	1	1							3

Ratings: 3 for high, 2 for substantial, 1 for low. To be followed in mapping.

Module No	Contents of Module	Hrs	Cos
1	**Introduction: definition** of robot, Need and importance, Type of robots, Robot Classifications: degrees of freedom; degrees of movements, robot configuration; accuracy and repeatability, robot Applications.	**08**	MEE655.1 MEE655.2
2	**Drives and component systems:** Basic control system concepts - control system analysis - robot actuation and fed back, Manipulators - Brief Robot dynamics. Types of Robot and effectors - Grippers - Tools as end effectors - Robot/End - effort interface.	**10**	MEE655.2 MEE655.3
3	**Sensors and sensing:** Range sensing - Proximity sensing - Touch sensing - Force and Torque sensing, Linear position and displacement sensing, Image processing and object recognition.	**10**	MEE655.4
4	**Robot Programming:** Teaching of robots, Manual, walk through**,** teach pendant**,** Methods - languages - Capabilities and limitation.	**09**	MEE655.5
5	**Industrial Applications :** Application of robots in machining - Welding - Assembly - Material handling - Loading and unloading - CIM - Hostile and remote environments.	**08**	MEE655.6

TEXT BOOKS:

1. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, "Robotic Engineering - An Integrated Approach", Prentice Hall India, **ISBN-13:** 978-8120308428
2. Mikell P. Groover, Mitchell Weiss, "Industrial robotics, technology, Programming and Applications ", McGraw Hill International Editions, 2nd Ed, **and ISBN:** 9781259006210

REFERENCE BOOKS:

1. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, "Robotic engineering - An Integrated Approach ", Prentice Hall Inc, Englewoods Cliffs, NJ, USA, **and ISBN-13:** 978-8120308428
2. K.S. Fu., R.C.Gonalez, C.S.G.Lee, "Robotics Control sensing ", Vision and Intelligence, McGraw Hill International Edition, 1st Ed, **ISBN:** 9780070265103

Assessment Pattern

CIE (50 Marks - Theory)

Bloom's Category	Tests	Assignments	Quizzes	External participation
Marks	**25**	**10**	**5**	**10**
Remember	5			
Understand	5			
Apply	5	5	5	5
Analyze	5	5		5
Evaluate	5			
Create				

SEE (50 Marks - Theory)

Bloom's Category	Tests(theory)
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

SUSTAINABLE ENERGY SOURCES

Course Code	MEE656
L: P: T: S	3:0:0:0
Exams Hours	03

Credits	03
CIE Marks	50
SEE Marks	50

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

MEE656.1	Understand The principles that underlie the ability of various natural phenomena to deliver solar energy
MEE656.2	Analyze the technologies that are used to harness the power of solar energy
MEE656.3	Analyze The positive and negative aspects of solar energy in relation to natural and human aspects of the environment.
MEE656.4	Evaluate the challenges of designing, promoting and implementing renewable energy solutions
MEE656.5	Understand their role in lifelong learning, social responsibility, and professional and ethical responsibilities in implementing sustainable engineering solutions.
MEE656.6	Apply the major 'big picture' questions in the area of energy resources

Mapping of Course outcomes to Program outcomes:

	PO 1	PO2	PO 3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	**PSO 1**	**PSO 2**
MEE656.1	3												3	
MEE656.2	3	3											3	
MEE656.3	3	3											3	
MEE656.4	3	3											3	
MEE656.5	3												3	
MEE656.6	3												3	

Ratings: 3 for high, 2 for substantial, 1 for low. To be followed in mapping.

Module No	Contents of Module	Hrs	Cos
1	INTRODUCTION: Energy demand growth and supply : Historical Perspectives ; Fossil fuels: Consumption and Reserve ; Environmental Impacts of Burning of Fossil fuels ; Sustainable Development and Role of Renewable Energy BIOMASS ENERGY: Biomass: Sources and Characteristics; Wet biogas plants; Biomass gasifiers: Classification and Operating characteristics; Updraft and Downdraft gasifiers; Gasifier based electricity generating systems; Maintenance of gasifiers.	9	**MEE656.1 MEE656.2**
2	SOLAR ENERGY BASICS: Solar geometry; Primary and Secondary Solar energy and Utilization of Solar Energy. Characteristic advantages and disadvantages. Low temperature applications: solar water heating, space heating, drying.	9	**MEE656.3**
3	SOLAR THERMAL ELECTRICITY GENERATION: Solar concentrators and tracking; Dish and Parabolic trough concentrating generating systems, Central tower solar thermal power plants; Solar Ponds.	9	**MEE656.3**

4	SOLAR PHOTOVOLTAIC SYSTEMS: Basic principle of power generation in a PV cell ; Band gap and efficiency of PV cells ; Manufacturing methods of mono- and polycrystalline cells ; Amorphous silicon thin film cells, Single and multi junction cells ; Application of PV ; Brief outline of solar, PV stand-alone system design ; Storage and Balance of system.	9	**MEE656.4**
	GEOTHERMAL ENERGY: Geothermal sites in India; High temperature and Low temperature sites; Conversion technologies- Steam and Binary systems; Geothermal power plants.		
5	WIND Energy Systems: Types of turbines, Coefficient of Power, Betz limit, Wind electric generators, Power curve; wind characteristics and site selection; Wind farms for bulk power supply to grid; Potential of wind electricity generation in India and its current growth rate. OCEAN ENERGY: Tidal power plants: single basin and two basis plants, Variation in generation level; Ocean Thermal Electricity Conversion (OTEC); Electricity generation from Waves: Shoreline and Floating wave systems.	8	**MEE656.5** **MEE656.6**

TEXT BOOKS:

1. Twidell J and Weir T., Renewable Energy Resources, Taylor & Francis ,2nd Ed, **ISBN-13:** 978-0419253303
2. Godfrey Boyle, Renewable energy, Oxford Press , 3rd Ed, **ISBN-13:** 978-0199545339
3. V.V.N. Kishore, Renewable Energy engineering and Technology: Principles and Practice, TERI Press. **ISBN-13:** 978-89930939
4. Rai G.D., Non-Conventional Energy Sources, Khanna publication, 5th Ed, ISBN 13- 978-81-7409-073-8

Assessment Pattern

CIE (50 Marks - Theory)

Bloom's Category	Tests	Assignments	Quizzes	External participation
Marks	**25**	**10**	**5**	**10**
Remember	5			
Understand	5			
Apply	5	5	5	5
Analyze	5	5		5
Evaluate	5			
Create				

SEE (50 Marks - Theory)

Bloom's Category	Tests(theory)
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

APPENDIX A

Outcome Based Education

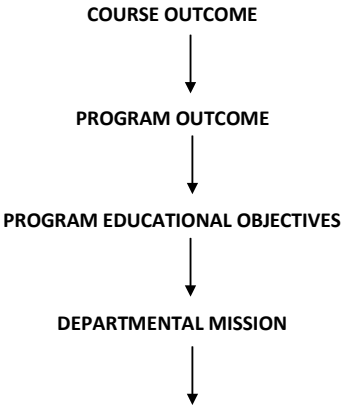
Outcome-based education (OBE) is an educational theory that bases each part of an educational system around goals (outcomes). By the end of the educational experience each student should have achieved the goal. There is no specified style of teaching or assessment in OBE; instead classes, opportunities, and assessments should all help students achieve the specified outcomes.
There are three educational Outcomes as defined by the National Board of Accreditation:

Program Educational Objectives: The Educational objectives of an engineering degree program are the statements that describe the expected achievements of graduate in their career and also in particular what the graduates are expected to perform and achieve during the first few years after graduation. [nbaindia.org]

Program Outcomes: What the student would demonstrate upon graduation. Graduate attributes are separately listed in Appendix C

Course Outcome: The specific outcome/s of each course/subject that is a part of the program curriculum. Each subject/course is expected to have a set of Course Outcomes

Mapping of Outcomes



Appendix B

Graduates Attributes as per NBA

1. **Engineering Knowledge**: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

2. **Problem Analysis**: Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

3. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.

4. **Conduct** investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.

5. **Modern Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society**: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

7. **Environment and Sustainability**: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.

11. **Project Management and Finance**: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long Learning**: Recognize the need for and have the preparation and ability to Engage in independent and life- long learning in the broadest context of technological
Change.

APPENDIX C

BLOOM'S TAXONOMY

Bloom's taxonomy is a classification system used to define and distinguish different levels of human cognition—i.e., thinking, learning, and understanding. Educators have typically used Bloom's taxonomy to inform or guide the development of assessments (tests and other evaluations of student learning), curriculum (units, lessons, projects, and other learning activities), and instructional methods such as questioning strategies. **[eduglosarry.org]**