NEW HORIZON
COLLEGE OF ENGINEERING

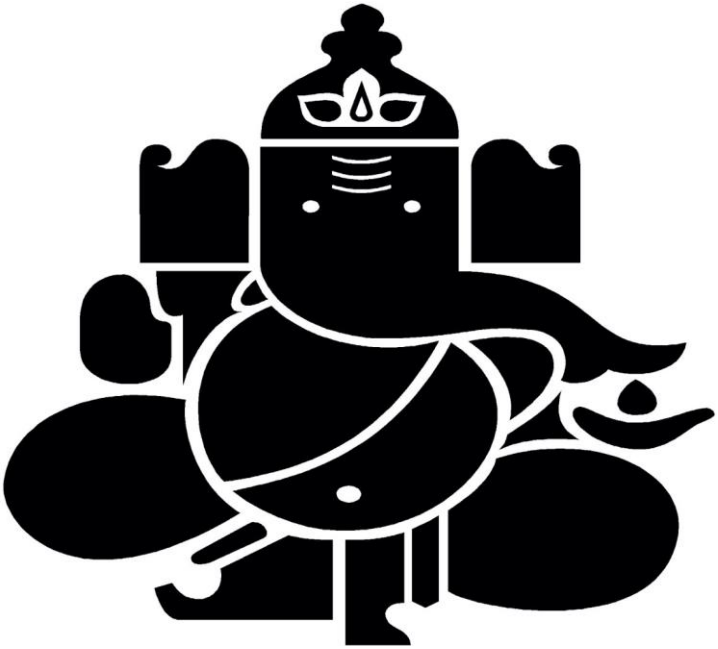
Autonomous College Permanently Affiliated to VTU, Approved by AICTE & UGC
Accredited by NAAC with 'A' Grade, Accredited by NBA

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

2016 & 2017 BATCH

BE - Mechanical Engineering

Fifth and Sixth Semesters
Scheme and Syllabus



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

Subject Code	Professional Elective-PE2
MEE651	Nanotechnology
MEE652	Fracture Mechanics
MEE653	Product Life Cycle Management
MEE654	Supply Chain Management
MEE655	Computational Fluid Dynamics

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

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

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	

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

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

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	

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

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 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	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	

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)

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

SEE (25 Marks - Theory)

Bloom's Category	Total
Marks – 25	**25**
Remember	4
Understand	3
Apply	8
Analyze	8
Evaluate	2
Create	

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

Ratings: 3 for high, 2 for substantial, 1 for low.

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

REFRIGERATAION 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**

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

Module No	Contents of Module	Hrs	COs
1	**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	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

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** **MEE564.6**

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 MEE565.6**
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

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

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**	**Credits**	**04**
L: P: T: S	**3:0:1:0**	**CIE Marks**	**50**
Exams Hours	**03**	**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 the 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
MEE63.2	3	1												3
MEE63.3	3		3	2						1				3
MEE63.4			3		1									3
MEE63.5			3	2			1							3
MEE63.6			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	**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	Understand the utilization parameters of machine and their capabilities
MEE64.2	Enhance the standards of system design by employing the computer aided systems
MEE64.3	Analyse Flow lines and solve problems line balancing methods for manufacturing
MEE64.4	Development of manufacturing ethics through globalization
MEE64.5	Design and development of various types of computer aided manufacturing and planning systems
MEE64.6	Apply the knowledge to practical engineering problem for better solutions by staying updated with latest developments and participation in competitive examinations.

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	Introduction to automation-Definition, types, merits and Criticism, Manufacturing plants and operations-automation strategies, Production concepts, MLT, Mathematical Models & Costs of Manufacturing Operations, Working syntax such as G-Codes and M-Codes for CNC Programming Introduction to concepts of IoT, Overview of IoT-Enabled Manufacturing System What is Machine Learning, Importance of Machine learning in Automation, machine learning algorithms Lab: CNC (Absolute Programming) and Python Programming	**9**	**MEE64.1**
2	Automated Flow lines, Analysis of Automated Flow Lines, Automated Guided Vehicle, Automated Storage/Retrieval Systems, Product identification system, Automated Assembly Systems, Automated Inspection Principles and Methods, Building Blocks of Automation System Lab: CNC Programming for Turning, Milling and Drilling	**9**	**MEE64.2**
3	IoT-Enabled Smart Assembly station: RFID-Based Applications in Assembly line, Assistant services for Assembly Line, Architecture of IoT-Enabled Smart Assembly station, Real-Time status monitoring, Real-Time Production guiding, Real-Time Production data sharing, Real-Time Production Requeuing. Data Acquisition and Control Unit: Hardware: Introduction, Basic Modules, Functional Modules, DACU Capacity Expansion, System Cables, Integrated Assemblies, DACU Construction, Data Exchange on Bus, Summary Data Acquisition and Control Unit: Software: Introduction, Software Structure, Application Programming, Summary	**9**	**MEE64.3**

	Lab: The Raspberry Pi platform and Python Programming for Raspberry Pi.		
4	Describe or summarise a set of data. Measure of central tendency and measure of dispersion. The mean, median, mode, kurtosis and skewness Standard deviation and Variance. Types of distribution. Hypothesis Testing, Basics of Hypothesis Testing, Supervised Learning-Linear Regression, Logistics Regression, Decision Tree. Lab: Regression Model Building using Python Programming.	**9**	**MEE64.4**
5	IoT and Programming enabled case studies: Smart irrigation using IoT, Weather Monitoring, System using Raspberry Pi, Weather update system with IoT, Home Automation using IoT, Automated Street light using IoT, Smart water monitoring, Facial recognition door Lab: Model Building and Prototype development using Arduino and Programming.	**8**	**MEE64.5** **MEE64.6**

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	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	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	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	

NANO TECHNOLOGY

Course Code	MEE651
L: T: P	3:0:0
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	Understand characterization and properties which provide an overview of nanostructures evincing their fascinating properties unseen otherwise.
MEE651.2	Analyse materials from nano to macro length scale, and its adoption in nature (bio mimicking) will also be emphasized.
MEE651.3	Demonstrate the ability to read and analyze current engineering methodologies to determine various methods and techniques used in nano technology.
MEE651.4	The student will demonstrate approaches to engineering nano materials and nano structures.
MEE651.5	To learn about nano sensors and their applications in mechanical, electrical, electronic, magnetic, chemical field.
MEE651.6	Understand the importance of nano machines.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE651.1	3												3	
MEE651.2	3	3											3	
MEE651.3	3	3											3	
MEE651.4	3												3	
MEE651.5	3	3											3	
MEE651.6	3												3	

Module No	Contents of Module	Hrs	Cos
1	**Overview of Nanostructures and Nanomaterials:** classification, Crystalline nanomaterials, Hybrid nanomaterials, the two approaches (bottom up and top down) followed for the synthesis of nanomaterials. Nomenclature and classification-Morphology of different synthetic nanomaterials- a comparison of their electronic structure/structure and other features with the respective bulk materials. **Nanomaterials in Nature:** Nacre, Gecko, Teeth. **An introduction to Nanobiology**	8	**MEE651.1**
2	**Novel properties of nano materials**-size and shape dependent optical, emission, electronic, transport, photonic, refractive index, mechanical, magnetic catalytic/photocatalytic properties.	9	**MEE651.2**
3	**Synthesis methodologies:** Sol-gel, Micromulsion, CVD,PVD, Molecular beam epitaxy, Vapor (solution)-liquid-solid growth, (VLS or SLS), Spary Pyrolysis, Template based synthesis,Lithography	9	**MEE651.3**
4	**Various kind of Nanostructures:** Carbon Nanotubes, Fullerenes, Nanowires, Quantum Dots, Self-assembly of nanostructures, Core-shell nanostructures, Metal and metal oxide nanowires. Applications of nanostructures. Nanocomposites: Reinforcement in Ceramics, Drug delivery,	9	**MEE651.3 MEE651.4**

	Giant magnetoresistance, etc. Cells response to Nanostructures. **Thermodynamics of Nanomaterials**		
5	**Nanosensors –** what make them possible nanoscale organization for sensors characterization nanosensors based on optical properties nanosensors based on quantum size effects electrochemical sensors sensors based on physical properties nanobiosensors sensors of the future. **Molecular Nano machines–** covalent and non-covalent approaches molecular motors and machines – other molecular devices single molecular devices practical problems involved. **Nanotribology** studying tribology on the nanoscale applications.	**9**	**MEE651.5 MEE651.6**

TEXT BOOKS:

1. "Nano: The Essentials Understanding nanoscience and nanotechnology" by T. Pradeep, Tata McGraw-Hill Education, 2017, ISBN-13 978-0070617889.
2. "Nanostructures and Nanomaterials" by Guozhong Cao and Ying Wang, 2nd Edition, Imperial College Press, 2011 ISBN-13 978-9814324557.
3. "Nanotechnology: An introduction to synthesis, Properties and application of Nanomaterials" by Thomas Varghese & K M Balakrishna, Atlantic Publications, 2012, ISBN-13 978-8126916375

REFERENCE BOOKS:

1. "Nanomaterials, Nanotechnology and Design: an introduction to Engineers and Architects", by D Michael Ashby, Paulo Ferreira & Daniel L, Butterworth Heinemann Publication, 2009, ISBN-13 978-0750681490
2. "Nanotechnology: Basic Science and Emerging Technologies" by Mickwilson, Geoff Smith and Kamali, Chapman publication 2002, ISBN-13 978-1584883395
3. "Nanophysics and Nanotechnology- an introduction to modern concepts in nanoscience" by Edward L wolf, 2nd edition John wiley and sons. 2006 ISBN-13 978-5631478935

Assessment pattern:

1. CIE- (50 Marks Theory)

Bloom's Category	**Tests**	**Assignments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	5		
Understand	5	5	5
Apply	5	5	5
Analyze	5	5	
Evaluate	5		
Create			

2. SEE – (50 Marks)

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

FRACTURE MECHANICS

Course Code	MEE652
L: T: P	3:0:0
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	Apply the basic concepts of Fracture Mechanics in engineering design and manufacture for brittle and ductile materials.
MEE652.2	Acquire knowledge on different modes of crack propagation and analyze the plane stress and plane strain condition.
MEE652.3	Investigate the difference between Linear Elastic Fracture Mechanics and Elastic Plastic Fracture Mechanics in the field of engineering. .
MEE652.4	Design the different types of specimen for fatigue and fracture analysis.
MEE652.5	Evaluate CTOD by using different methods of FM approach, and analyze by using analysis software.
MEE652.6	Conduct investigations on various NDT methods to determine the fracture, crack and flaws in the materials.

Mapping of Course outcomes to Program outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
MEE84.1	3		1											
MEE84.2		2			1									
MEE84.3				2		2								
MEE84.4					1					1				2
MEE84.5	3			2	1									2
MEE84.6	3	2										1		

Module No	Contents of Module	Hrs	Cos
1	**Fracture Mechanics Principles:** Introduction, Mechanisms of Fracture, a crack in structure, the Griffith's criterion, modern design – strengths, stiffness and toughness. Stress intensity approach **Stress Analysis For Members With Cracks:** Linear elastic fracture mechanics, Crack tip stress and deformations, Relation between stress intensity factor and fracture toughness, Stress intensity based solutions. Crack tip plastic zone estimation, Plane stress and plane strain concepts. Dugdale approach, Spectacular Failures-Discussion on Boston molasses failure, Liberty ship failure, Ductile-brittle transition temperature and its relevance	9	**MEE652.1 MEE652.3 MEE652.6**

2	**Elastic – Plastic Fracture Mechanics: I**ntroduction, Elasto–plastic factor criteria, crack resistance curve, J-integral, Crack opening displacement, crack tip opening displacement. Importance of R- curve in fracture mechanics, The use of Crack Tip Opening Displacement (CTOD) criteria. Experimental determination of CTOD. Parameters affecting the critical CTOD.	**9**	**MEE652.2 MEE652.6**
3	**Dynamic And Crack Arrest:** Introduction, the dynamic stress intensity and elastic energy release rate, crack branching, the principles of crack arrest, the dynamic fracture toughness.Comparison of crack growth and critical value of K by MTS and SED **Fatigue And Fatigue Crack Growth Rate:** Fatigue loading, various stages of crack propagation, the load spectrum, approximation of the stress spectrum, the crack growth integration, fatigue crack growth laws.Paris Law and Sigmoidal Curve, crack clouser	**9**	**MEE652.2 MEE652.3 MEE652.6**
4	**Fracture Resistance Of Materials: Fracture criteria, fatigue cracking criteria, effect of alloying and second phase particles, effect of processing and anisotropy, effect of temperature, closure. Computational Fracture Mechanics: Overview of numerical methods, traditional methods in computational fracture mechanics – stress and displacement marching,**	**8**	**MEE652.4 MEE652.6**
5	**Fracture Toughness Testing Of Metals: Specimen size requirements, various test procedures, effects of temperature, loading rate and plate thickness on fracture toughness. Fracture testing in shear modes, fatigue testing, NDT methods,NASGRO, AFGROW, Summary of empirical fatigue crack growth models, Crack initiation, Intrusion and extrusion, Evidence of slip bands.**	**9**	**MEE652.4 MEE652.6**

TEXT BOOKS:

1. **Introduction to fracture mechanics,** Dietmar and Thomas seeling**, 2017** ISBN-13: 978-3319710891,ISBN-10: 3319710893
2. **Fracture of Engineering Brittle Materials,** Jayatilake, Applied Science, London**.** 2014. ISBN-13-978-3345457810.
3. **Introduction to Fracture Mechanics, Karen Hellan,** 2000, ISBN-13-978-3348561654

REFERENCE BOOKS:

1. **Fracture Mechanics –** Fundamentals and Application, T.L. Anderson, CRC press ,4TH EDITION,**2017,ISBN-13:** 978-1498728133

2. **Elementary Engineering Fracture Mechanics,** David Broek, ArtinusNijhoff, London **2015. ISBN-13:** 978-9024726561

3. **Fracture and Fatigue Control in Structures,** Rolfeand Barsom, Printice Hall **2015. ISBN- 13:** 978-0133298635

4. **Fundamentals of Fracture Mechanics, Knott,** Butterworth & Co Publishers Ltd**,2014.**

Assessment pattern:

1. CIE- (50 Marks Theory)

Bloom's Category	**Tests**	**Assignments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	5		
Understand	5	5	5
Apply	5	5	5
Analyze	5	5	
Evaluate	5		
Create			

2. SEE – (50 Marks)

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

PRODUCT LIFE CYCLE MANAGEMENT

Course Code	MEE653
L: T: P	3:0:0
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:

MEE653.1	Integrate the various stages of PLM into engineering product categories and portfolios that will evaluate into commercial success.
MEE653.2	Interpret the data with information and/or communicate the same for the supply chain and value supplier chain quotation to ensure sustainable development.
MEE653.3	Examine life cycle management strategies and knowledge to develop new and/or appropriate engineering design solutions in engineering environment.
MEE653.4	Translate and implement the legal, environmental and international regulatory frame works into product design, development and manufacturing requirements.
MEE653.5	assess system for corrective and preventive action to track production Quality issues through digital manufacturing.
MEE653.6	Incorporate preventive approaches concentrating on minimizing waste, hazard and risk associated with product design, development and Manufacturing.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE653.1	3		3										3	
MEE653.2	3			1	3									
MEE653.3	3		3						1					
MEE653.4		2	3											
MEE653.5					3									3
MEE653.6					3						1		3	

Module No	Contents of Module	Hrs	Cos
1	**Introduction to Product Life Cycle Management(PLM):** Definition, PLM Lifecycle Model, Threads of PLM, Need for PLM, Opportunities and Benefits of PLM, Views, Components and Phases of PLM, PLM feasibility Study, PLM Visioning.	**9**	**MEE653.1**
2	**PLM Concepts, Processes and Workflow:** Characteristics of PLM, Environment Driving PLM, PLM Elements, Drivers of PLM, Conceptualization, Design, Development, Validation, Production, Support of PLM. **Collaborative Product Development:** Engineering Vaulting, Product Reuse, Smart Parts, Engineering Change Management	**9**	**MEE653.2 MEE653.3**
3	**Collaborative Product Development** (continued) Bill of Materials and Process Consistency, Digital Mock-Up and Prototype Development, Design for Environment, Virtual Testing and Validation, Marketing Collateral.	**9**	**MEE653.3 MEE653.4**
4	**Digital Manufacturing – PLM:** Digital Manufacturing, Benefits of Digital Manufacturing, Manufacturing the First-One, Ramp Up, Virtual Learning Curve, Manufacturing the Rest, Production Planning.	**9**	**MEE653.4**

5	**Developing a PLM Strategy and Conducting a PLM Assessment:** Strategy, Impact of strategy, Implementing a PLM strategy, PLM Initiatives to Support Corporate Objectives, Infrastructure Assessment, Assessment of Current Systems and Applications.	**8**	**MEE653.5 MEE653.6**

TEXT BOOKS:

1. **Product Lifecycle Management :** Grieves, Michael, McGraw-Hill Publications, Edition 2013, ISBN: 978-0071452304.
2. **Product Lifecycle Management Volume I :** Stark, John, Springer, 3rd Edition, 2016, ISBN: 978-3319174396.
3. **Product Lifecycle Management Volume II :** Stark, John, Springer, 3rd Edition, 2016, ISBN: 978-3319244341

REFERENCE BOOKS:

1. Fabio Guidice, Guido La Rosa, **Product Design for the environment -A life cycle approach**, Taylor and Francis 2013, ISBN: 978-1420001044
2. Robert J. Thomas, "NDP: "**Managing and forecasting for strategic processes**", Wiley Publications, 2013 ISBN: 978-0471572268
3. Stark, John, **"Product Life cycle Management: Paradigm for 21st Century Product Realization**", Springer-Verlag, 2015. ISBN: 978-3-319-17440-2
4. Saaksvuori, Antti and Immpnen, Anselmi. **" Product Lifecycle Management**", Springer- Verlag, 2013. ISBN 978-3-540-26906-9
5. **PDM : Product Data Management :** Burden, Rodger, Resource Pub, 2013. ISBN: 978- 0970035226
6. **Suggested Software Packages :**Catia V5R19, Delmia V5R19, 3D via Composer, 3DXML player, Smart Team V5R19

Assessment pattern:

1. CIE- (50 Marks Theory)

Bloom's Category	**Tests**	**Assign ments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	5		
Understand	5	5	5
Apply	5	5	5
Analyze	5	5	
Evaluate	5		
Create			

2. SEE – (50 Marks)

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

SUPPLY CHAIN MANAGEMENT

Course Code	MEE654
L: T: P	3:0:0
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	Understand the functions of logistics and supply chain management
MEE654.2	Apply the concepts and activities of the supply chain to practical applications in organizations
MEE654.3	Identify the various technologies used in logistics and supply chain management
MEE654.4	Evaluate various cases studies for effective supply chain management and its implementation
MEE654.5	Analyze the various costs associated with inventory management
MEE654.6	Identify the different types of purchasing and vendor management activities to be applied for industrial applications

Mapping of Course outcomes to Program outcomes:

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

Module No	Contents	Hr's	CO's
1	**Introduction:** Basic concepts & philosophy of SCM, essential features, decision phases – process view, supply chain framework, key issues in SCM and benefits.	09	**MEE654.1, MEE541.2**
2	**Designing the supply chain network:** Designing the distribution network, role of distribution, factors influencing distribution, design options, distribution networks in practice, network design in the supply chain, factors affecting the network design decisions. Designing and Planning Transportation Networks, role of transportation, modes, design options, tailored transportation.	09	**MEE654.3**
3	**Inventory Management:** Concept, various costs associated with inventory, EOQ, buffer stock, lead time reduction, reorder point / re-order level fixation, ABC analysis, SDE/VED Analysis.	09	**MEE654.4,**

4	**Purchasing and vendor management:** Centralized and decentralized purchasing, functions and purchase policies, vendor rating/ evaluation, single vendor concept, account for materials, just in time & Kanban systems of inventory management. **Recent issues in SCM:** Role of computer/ IT in supply chain management, CRM Vs SCM, Benchmarking concept, features and implementation, outsourcing – basic concepts, value addition in SCM.	09	**MEE654.5**
5	**Logistics Management:** Logistics of part of SCM, logistics costs, logistics, sub-systems, inbound and out bound logistics bullwhip effects in logistics, distribution and warehousing management. Demand Management and Customer Service: Demand Management, CPFRP, customer service, expected cost of stock outs.	08	**MEE654.5, MEE654.6**

TEXT BOOKS:

1. A Logistic approach to Supply Chain Management – Coyle, Bardi, Longley, 1st Edition, Cengage Learning.
2. Supply Chain Logistics Management, Donald J Bowersox, Dand J Closs, M Bixby Coluper,2nd Edition, TMH, 2008.

REFERENCE BOOKS:

1. Supply chain management, Chopra Sunil and Peter Meindl - 3rd edition, Pearson, 2007.
2. Supply Chain Management-A Managerial Approach,Amith Sinha, Herbert, 2nd edition,TMH.
3. AText Book of Logistics and Supply chain management, Agarwal D.K. - 1st edition,Macmillan

Assessment pattern:

1. CIE- (50 Marks Theory)

Bloom's Category	**Tests**	**Assignments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	5		
Understand	5	5	5
Apply	5	5	5
Analyze	5	5	
Evaluate	5		
Create			

2. SEE – (50 Marks)

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

COMPUTATIONAL FLUID DYNAMICS

Course Code	MEE655
L: T: P	3:0:0
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 do the following:

MEE655.1	Understand in-depth introduction to the methods and analysis techniques used in computational solutions of fluid mechanics and heat transfer problems.
MEE655.2	Demonstrate experience in the application of CFD analysis to real Engineering designs.
MEE655.3	Apply the knowledge to Model problems and to study the interaction of physical processes and numerical techniques.
MEE655.4	Analyze Contemporary methods for boundary layers, incompressible viscous flows, and inviscid compressible flows are studied.
MEE655.5	Design problems using proper turbulence models
MEE655.6	Solve practical problems related to engineering

-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	3	3										3
MEE655.2	3	3	3	3										3
MEE655.3	3	3	3	3										3
MEE655.4	3	3	3	3										3
MEE655.5		3	3	3										3
MEE655.6			3	3										3

SYLLABUS			
Module No	**Contents of the Module**	**Hours**	**COs**
1	**Introduction To CFD:** CFD ideas to understand, CFD Application, Governing Equations (no derivation) of flow; continuity, momentum, energy. Conservative & Non- conservative forms of equations, Integral vs. Differential Forms of Equations. Form of Equations particularly suitable for CFD work. Shock capturing, Shock fitting, Physical Boundaryconditions.	**9**	**MEE655.1**

2	**Mathematical Behavior of Partial Differential Equations and Discretization:** Classification of partial differential equations and its Impact on computational fluid dynamics, Essence of discretization, order of accuracy consistency of numerical schemes, Lax's Theorem, convergence, Reflection Boundary condition, case studies on PDE	**9**	**MEE655.2**
3	Mathematical Behavior of Partial Differential Equations and Discretization: Higher order Difference quotients. Explicit & Implicit Schemes, Error and analysis of stability, Error Propagation, Stability properties of Explicit & Implicit schemes. Solution Methods ofFinite Difference Equations: Time & Space Marching, Alternating Direction Implicit (ADI) Schemes. Relaxation scheme, Jacobi and Gauss-Seidel techniques, Lax- Wendroff first order scheme, Lax- Wendroff with artificial viscosity	**9**	**MEE655.3**
4	**Grid Generation:** Structured Grid Generation: Algebraic Methods, PDE mapping methods, use of grid control functions, Surface gridgeneration, Multi Block Structured grid generation, overlapping and Chimera grids. Unstructured Grid Generation: Delaunay-Vuronoi Method, advancing front methods (AFM Modified for Quadrilaterals, iterative paving method, Quadtree&Octree method).**Adaptive Grid Methods:** Multi Block Adaptive Structured Grid Generation, Unstructured adaptive Methods. Mesh refinement methods, and Mesh enrichmentmethod.	**9**	**MEE655.4** **MEE655.6**
5	**Finite Volume Techniques:** Finite volume Discritisation-Cell Centered Formulation, High resolution finite volume upwind scheme Runge-Kutta stepping, Multi-Step Integration scheme.Cell vertex Formulation. **Application to Turbulence**- Models,Large eddy simulation, Direct Numerical Solution,Post- processing and visualization, Journal based on application to turbulence,ANSYS flow analysis report on symmetric and camberedaerfoil.	**8**	**MEE655.5** **MEE655.6**

TextBooks

1. **John D Anderson Jr**" Computational Fluid Dynamics, The Basics with Applications", McGraw Hill InternationalEdn;2014.
2. **T J Chung** "Computational Fluid Dynamics", Cambridge University Press,2015.

ReferenceBooks:

1. **F. Wendt (Editor) "**Computational fluid Dynamics - An Introduction", Springer – Verlag, Berlin;2012.
2. **Charles Hirsch** "Numerical Computation of Internal and External Flows", Vols. I and II. John Wiley & Sons, New York;2012.
3. **JiyuanTu, Guan HengYeoh, and Chaoqun Liu**, Computational Fluid dynamicsbook
4. **J. Tu, G.H. Yeoh, and C. Liu** "Computational Fluid Dynamics - A Practical Approach", ElsevierInc.,2015
5. **T. Cebeci, J.P. Shao, F. Kafyeke, and E. Laurendeau**"Computational Fluid Dynamics for Engineers," ,Horizons Publishing, 2016, ISBN0-9766545-0-4.

Assessment pattern:

1. CIE- (50 Marks Theory)

Bloom's Category	**Tests**	**Assign ments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	5		
Understand	5	5	5
Apply	5	5	5
Analyze	5	5	
Evaluate	5		
Create			

2. SEE – (50 Marks)

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

APPENDIX A

Outcome Based Education

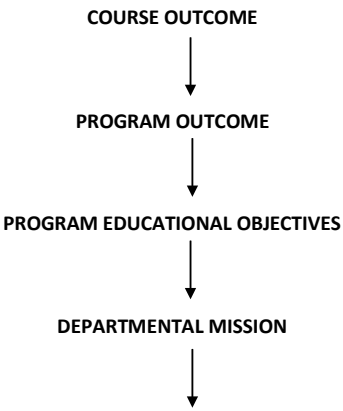
Outcome-based education (OBE) is an educational theory that bases each part of an educational system around goals (outcomes). By the end of the educational experience each student should have achieved the goal. There is no specified style of teaching or assessment in OBE; instead classes, opportunities, 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]**