Batch of 2019-2023

BE – Mechanical Engineering

Fifth and Sixth Semesters B.E

Scheme and Syllabus

CONTENTS

VISION

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

MISSION

➢ To impart excellent education by proving 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 students in intellectual, entrepreneurial and ethical challenges through active participation by critical thinking.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

➢ **PEO 1**: The graduates will be able to apply the overall knowledge of Mechanical Engineering along with concepts of Mathematics, Science, Communication and Computing skills to understand specific problem areas and finding the optimal solutions for the same.

➢ **PEO 2**: The graduates will be able to implement ideas of Mechanical Engineering for the challenging tasks in the interdisciplinary areas like Electrical, Electronics, Computer Science, Civil, Bio-Technology and allied branches.

➢ **PEO 3**: The graduates will be widely talented in the fields of manufacturing, service and design industries, which will not only improve their employability but also aid in establishing the above said industries.

➢ **PEO 4**: The graduates will develop lifelong learning attitudes, ethics and values that will help their career employability and growth in engineering, academia, defence, state and central government sectors.

MAPPING OF PEOs TO DEPARTMENT MISSION

Program Educational Objectives	M1	M2	M3
PEO 1	3	2	3
PEO 2	2	1	3
PEO 3	3	2	2
PEO 4	2	2	3

PROGRAM OUTCOMES (POs)

Graduate Attributes	PO #	Program Outcomes
Engineering knowledge	1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex mechanical engineering problems
Problem Analysis	2	Identify, formulate, review research literature, and analyze complex engineering problems in Mechanical Engineering reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
Design Development of Solutions	3	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.
Conduct Investigations of Complex Problems	4	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.
Modern tool usage	5	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities in Mechanical Engineering with an understanding of the limitations.
The Engineer and society	6	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.
Environment and Sustainability	7	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.
Ethics	8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
Individual & team work	9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
Communication	10	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.
Project management and finance	11	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, manage projects and in multidisciplinary environments.
Lifelong learning	12	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.

PROGRAM SPECIFIC OUTCOMES (PSOs)

After successful completion of mechanical Engineering Program, the graduates will be able to:

PSO1	Specify, fabricate, test and operate various machines along with essential documentations.
PSO2	Analyze, design, develop and implement the concepts of mechanical systems and processes towards product development

New Horizon College of Engineering
Department of Mechanical Engineering

Fifth Semester Scheme												
Sl. No.	Course Code	Course Name	Credit Distribution				Overall Credits	Contact Hours	Marks			
			L	T	P	S			CIE	SEE	Total	
1	20MEE51	Machine Theory & Mechanism Design	2	1	0	0	3	4	50	50	100	
2	20MEE52	Heat Power Cycles	2	1	0	0	3	4	50	50	100	
3	20MEE53	Rotor Dynamics	2	1	0	0	3	4	50	50	100	
4	20MEE54	Design of Machine Elements-I	3	1	0	0	4	5	50	50	100	
5	20MEE55	Project Management & Entrepreneurship	2	0	0	0	2	2	25	25	50	
6	20MEE56X	ProfessionalElective-I	3	0	0	0	3	3	50	50	100	
7	20MEL51	Machine Theory & Mechanism DesignLab	0	0	1	0	1	2	25	25	50	
8	20MEL52	Heat Power CyclesLab	0	0	1	0	1	2	25	25	50	
9	20MEL53	Rotor Dynamics Lab	0	0	1	0	1	2	25	25	50	
10	20MEE57	Mini Project-II	0	0	2	0	2	4	25	25	50	
Total							23	32	375	375	750	

Professional Elective-I		
Sl. No.	Course Code	Course Name
1	20MEE561	Mechatronics and Microprocessors
2	20MEE562	Composite Materials
3	20MEE563	Refrigeration and Air conditioning
4	20MEE564	Smart Materials
5	20MEE565	Theory of Elasticity
6	20MEE566	IIOT Embedded systems

New Horizon College of Engineering
Department of Mechanical Engineering

Sl. No.	Course Code	Course Name	L	T	P	S	Overall Credits	Contact Hours	CIE	SEE	Total
			Credit Distribution						**Marks**		
1	20MEE61	Fundamentals ofHeat Transfer	2	1	0	0	3	4	50	50	100
2	20MEE62	Finite Element Methods	2	1	0	0	3	4	50	50	100
3	20MEE63	Design of Machine Elements-II	3	1	0	0	4	5	50	50	100
4	20MEE64X	ProfessionalElective-II	3	0	0	0	3	3	50	50	100
5	20MEE65X	ProfessionalElective-III	3	0	0	0	3	3	50	50	100
6	20NHOP6XXX	Open Elective-I	3	0	0	0	3	3	50	50	100
7	20MEL61	Fundamentals of Heat Transfer Lab	0	0	1	0	1	2	25	25	50
8	20MEL62	Finite Element Methods Lab	0	0	1	0	1	2	25	25	50
9	20MEE67	Mini Project-III	0	0	2	0	2	4	25	25	50
		Total					23	30	375	375	750

Sixth Semester Scheme

Sl. No.	Course Code	Course Name
		Professional Elective-II
1	20MEE641	Fundamentals of Tribology
2	20MEE642	Computer Graphics
3	20MEE643	Fundamentals of Plastic Mold Design and Die Design
4	20MEE644	Emerging Automotive Technologies
5	20MEE645	Advanced Robotics

Sl. No.	Course Code	Course Name
		Professional Elective-III
1	20MEE651	Nanotechnology
2	20MEE652	Fracture Mechanics
3	20MEE653	Product Life Cycle Management
4	20MEE654	Supply Chain Management
5	20MEE655	Computational Fluid Dynamics

FIFTH SEMESTER SYLLABUS

MACHINE THEORY AND MECHANISM DESIGN

Course Code	20MEE51
L: T: P:S	2:1:0:0
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:

20MEE51.1	Apply the concepts of kinematics and dynamics to analyze planar mechanisms.
20MEE51.2	Investigate the velocity and acceleration of mechanisms by Analytical and Graphical Methods.
20MEE51.3	Understand the concept of mechanism and design of different machines.
20MEE51.4	Realize the applications of Governors based on specific requirements.
20MEE51.5	Analyze the Problems involving static and dynamic balancing and develop the solutions forthe same using Graphical Method.
20MEE51.6	Review the concept of Gyroscopic effect and Visualize 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
20MEE51.1		2												3
20MEE51.2		2	1											3
20MEE51.3	3													3
20MEE51.4	3												1	3
20MEE51.5		2		3										3
20MEE51.6	3			3										3

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

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 Ambedkar 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

Module No	Module Contents	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	20MEE51.1
2	**Velocity and Acceleration Analysis of Mechanisms:** Velocity and acceleration analysis of inversions of four bar mechanism, slider crank mechanism by analytical methods. Cam, gear and gear trains	9	20MEE51.2 20MEE51.3
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	20MEE51.4
4	**Governors and flywheel:** 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, Flywheel	9	20MEE51.5
5	**Gyroscope:** Introduction, Processional angular motion, gyroscopic couple, Gyroscopic effect of a disc, ship, aero plane, two wheelers and four wheelers.	9	20MEE51.6

Assessment Pattern

CIE (50 Marks – Theory)

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

SEE (50 Marks – Theory)

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

HEAT POWER CYCLES

Course Code	20MEE52
L: T: P:S	2:1:0:0
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:

20MEE52.1	Apply the theoretical knowledge of internal combustion engines to determine the performance characteristics and draw heat balance sheet of petrol and diesel engines as ateam member or as an individual.
20MEE52.2	Develop sustainable solution for thermodynamic cycles of internal combustion engines byapplying laws of thermodynamics such that emission norms are attained.
20MEE52.3	Calculate the performance of gas turbines with reheat and regeneration, and discuss theperformance of combined cycle power plants.
20MEE52.4	Develop and enhance the sustainable thermal systems as a team, by minimizing the constraints which enables the student to have continuous learning
20MEE52.5	Perform the preliminary design of the major components or systems of a conventional or alternate power plant for sustainable environment.
20MEE52.6	Design a eco friendly room air conditioner and determine the properties of atmospheric airusing 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
20MEE52.1	3													
20MEE52.2	3		3											
20MEE52.3	3			2										3
20MEE52.4	3								1			1		3
20MEE52.5	3		3				2							3
20MEE52.6	3		3	2	1		2							3

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

TEXT BOOKS:
1) Applied Thermodynamics By R.K.Rajput , Lakmi Publications Ltd., 2ndEd,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

Module No	Module Contents	Hrs	COs
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	**20MEE52.1 20MEE52.2**
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 Stirlingcycle, Rankine cycle, Rankine cycle with superheat , The Enthalpy Entropy chart , Regenerative cycle **,binary vapor cycle, combined cycle ,different steam turbine arrangement**	9	**20MEE52.3**
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	**20MEE52.3 20MEE52.4**
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	**20MEE52.5**
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**, duct design Problems on with and without using Psychrometric chart.	8	**20MEE52.6**

Assessment Pattern

CIE (50 Marks – Theory)

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

SEE (50 Marks – Theory)

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

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ROTOR DYNAMICS

Course Code	20MEE53		Credits	03
L: T: P:S	2:1:0:0		CIE Marks	50
Exams Hours	03		SEE Marks	50

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

20MEE53.1	Apply basic concepts of Fluid Mechanics to conceptualize working of positive displacement machines and turbo machines
20MEE53.2	Analyze energy transfer through graphical and analytical methods in turbo machines
20MEE53.3	Determine various equipment sizing / design aspects of turbo machines based on engineering requirement.
20MEE53.4	Apply appropriate engineering techniques/methods to characterize the steam-based turbomachines and its thermodynamic analysis.
20MEE53.5	Investigate the concepts as a member of a team and make an effective presentation on the application of suitable turbo machines under / within the specified conditions.
20MEE53.6	Design and analysis of turbo machines by applying the knowledge to practical engineering problems for better sustainable 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
20MEE53.1	3													
20MEE53.2	3	3											3	
20MEE53.3	3		2										3	
20MEE53.4	3	3											3	
20MEE53.5									2	2				
20MEE53.6	3	3	2									1	3	

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

TEXT BOOKS:

1) An Introduction to Energy Conversion, Volume III, Turbo machinery, V. Kadambiand 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) Textbook of Turbo machines, M. S. Govinde Gowda and A. M. Nagaraj, M. M.Publications, 4Th Ed, 2008

Module No	Module Contents	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	20MEE53.1 20MEE53.2
2	**Energy exchange in power absorbing machines:** Radial flow compressorsand pumps– general analysis, Expression for degree of reaction, velocitytriangles, General analysis of axial flow pumps and compressors, degree ofreaction, velocity triangles, , Thermodynamics of Turbomachine 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, Cavitation's, Need for priming. Problems.	9	20MEE53.3
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 chokedflow simple problems on nozzles.	9	20MEE53.4
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	20MEE53.4
5	**Hydraulic Turbines:** Classification, Different efficiencies, Pelton turbine – velocity triangles, design parameters, Maximum efficiency. Francis turbine- velocity triangles, design parameters, runner shapes for different bladespeeds. Draft tubes- Types and functions. Kaplan and Propeller turbines - velocity triangles, design parameters. Performance Charts Problems.	8	20MEE53.5 20MEE53.6

Assessment Pattern

CIE (50 Marks – Theory)

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

SEE (50 Marks – Theory)

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

DESIGN OF MACHINE ELEMENTS-I

Course Code	20MEE54
L: T: P:S	3:1:0:0
Exams Hours	03

Credits	04
CIE Marks	50
SEE Marks	50

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

20MEE54.1	Understand the basic concepts of stress, strain in uni, bi & amp; tri axial state alongwith standard codes used in design.
20MEE54.2	Design the machine elements to withstand static and impact loading using different theories of failure.
20MEE54.3	Design for fatigue strength by considering stress concentration into account and design of shafts under fluctuating loads.
20MEE54.4	Design the threaded fastener and power screws to withstand parallel and perpendicular loads for both circular and rectangular base plates.
20MEE54.5	Design different types of joints, keys, couplings and different gears using design data handbook.
20MEE54.6	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
20MEE54.1	3	3	3	3										3
20MEE54.2	3	3	3	3										3
20MEE54.3	3	3	3	3										3
20MEE54.4	3	3	3	3										3
20MEE54.5	3	3	3	3										3
20MEE54.6	3	3	3	3										3

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

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

REFERENCE 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 CompanyLtd., ISBN:9789339221126
3) Machine Design, Robert L. Norton, Pearson Education. 5th edition, ISBN13:97801333567
4) Design of Machine Elements, M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayramand C. V Venkatesh, Pearson Education, 8th edition.

Module No	Module Contents	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), 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	20MEE54.1 20MEE54.2
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, Mean stress effects, crack life estimation, notches and their effects. (no numerical)	9	20MEE54.3
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	20MEE54.4 20MEE54.6
4	**Design of Knuckle joint, socket and spigot, power screw:** Design of **Knuckle** joint, **socket and spigot** cotter joint. Design of **powerscrews**, stresses in power screws, efficiency, and self-locking	8	20MEE54.5
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	20MEE54.5

Assessment Pattern

CIE (50 Marks – Theory)

Bloom's Category	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	3		
Understand	2		
Apply	7	5	5
Analyze	8	5	5
Evaluate	3	5	
Create	2		

SEE (50 Marks – Theory)

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

PROJECT MANAGEMENT & ENTREPRENEURSHIP

Course Code	20MEE55
L: T: P: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 student will be able to:

20MEE55.1	Apply basic principles of project management for real time projects
20MEE55.2	Identify the needs, roles and responsibilities of a leader for feasible and optimum allocation of projects.
20MEE55.3	Develop project execution plans for global and virtual projects to meet customer requirements with effective documentation
20MEE55.4	Apply appropriate techniques for scheduling and evaluation of projects with interpretation of data using Gantt charts and other monitoring techniques
20MEE55.5	Promote entrepreneurship as an individual or as a group by creating awareness on its needs and roles with respect to growth of economic development
20MEE55.6	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
20MEE55.1	3										3		3	
20MEE55.2										2	3		3	
20MEE55.3										2	3		3	
20MEE55.4	3	3									3		3	
20MEE55.5	3								1		3		3	
20MEE55.6		3									3		3	

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

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,
3) 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

Module No	Module Contents	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, projectmanagement processes, impact of delays in project completions, roles andresponsibilities of project leader, tools and techniques of project management. Project identification process, project initiation, and pre- feasibility study, prioritizing projects, securing and negotiating projects.	5	**20MEE55.1 20MEE55.2**
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.	5	**20MEE55.4**
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 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	5	**20MEE55.3 20MEE55.5**
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.	5	**20MEE55.2 20MEE55.4**
5	**Small Scale Industries**: Definition; Characteristics; Need and rationale;Objectives; Scope; role of SSI in Economic Development. Advantages of SSISteps to start and SSI - Government policy towards SSI; Different Policies ofSSI; Government Support for SSI during 5-year plans. Impact ofLiberalization, 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	5	**20MEE55.5 20MEE55.6**

Assessment Pattern

CIE (25 Marks – Theory)

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

SEE (25 Marks – Theory)

Bloom's Category	Tests (theory)
Remember	4
Understand	3
Apply	8
Analyze	8
Evaluate	2
Create	

MECHATRONICS AND MICROPROCESSORS

Course Code	20MEE561		Credits	03
L: T: P:S	3:0:0:0		CIE Marks	50
Exams Hours	03		SEE Marks	50

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

20MEE561.1	Develop the insight applications of the concepts in Mechatronics and Microprocessors.
20MEE561.2	Analyze signal conditioning system, different amplifiers Multiplexers and Data acquisition
20MEE561.3	Recognize the need and ability to engage in independent study and life-long learning oftechnology change in Automotive sector.
20MEE561.4	Analysis and develop the systems of mechatronics for the use of engineer and society.
20MEE561.5	Individual and teamwork in developing assembly language programs for competence intechnologies for applications in multidisciplinary settings for sustainable products.
20MEE561.6	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
20MEE561.1	3													
20MEE561.2		2												
20MEE561.3						1						2		2
20MEE561.4	3		1			1								2
20MEE561.5	3		1						2					2
20MEE561.6	3								2			2		

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

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,
2) Sensors and Robotics", McGraw Hill International Edition, 1995.
3) Mechatronics and Microprocessors, K. P. Ramchandran, G. K. Vijay Raghavan, M.S. Balasundran, Wiley, 1st Ed, 2009.
4) Mechatronics - Principles, Concepts and applications – Nitaigour and Premchand Mahilik - Tata McGraw Hill- 1st Ed, ISBN: 9780070483743
5) Mechatronics Principles & applications, Godfrey C. Onwubolu, Elsevier., 1st Ed, ISBN:
6) 9780750663793
7) Introduction Mechatronics & Measurement systems, David.G.
8) Aliciatore & Michael. B. Bihistaned, Tata McGraw Hill, 4th Ed, ISBN: 9789339204365

Module No	Module Contents	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	20MEE561.1
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	20MEE561.2
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	20MEE561.3
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	20MEE561.4
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	20MEE561.5 20MEE561.6

Assessment Pattern

CIE (50 Marks – Theory)

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

SEE (50 Marks – Theory)

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

COMPOSITE MATERIALS

Course Code	20MEE562		Credits	03
L: T: P:S	3:0:0:0		CIE Marks	50
Exams Hours	03		SEE Marks	50

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

20MEE562.1	Identify the suitability of composite materials for various engineering applications.
20MEE562.2	Ensure safe and sustainable processing techniques for composite materials
20MEE562.3	Apply the modern fabrication technique for enhancement of composite properties .
20MEE562.4	Examine the micro and macro characteristics of lamina
20MEE562.5	Analyze the influence of size, shape and particle distribution in MMC'S.
20MEE562.6	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
20MEE562.1	3	3											3	
20MEE562.2		3					1						3	
20MEE562.3	3												3	
20MEE562.4				2										3
20MEE562.5	3	3		2										3
20MEE562.6	3	3	2											

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

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 Hillinternational, 1994.
5) Composite Materials Handbook, Meing Schwaitz," McGraw Hill book company.1984

Module No	Module Contents	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	20MEE562.1 20MEE562.2
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 bagmolding **Advanced Processing Techniques**: Filament winding, pultrusion, pulforming, thermo - forming, injection, injection molding, liquid molding, blow molding.	9	20MEE562.2
3	**Fabrication of Composite Structures**: Cutting, machining, drilling, mechanical fasteners and adhesive bonding, joining, computer- aided design and manufacturing, tooling, fabrication of equipment. **Mechanical Properties - Stiffness and Strength:** Geometrical aspects – volume and weight fraction. Unidirectional continuous fibre, discontinuous fibers, Short fiber systems, woven reinforcements Mechanical Testing: Determination of stiffness and strengths of unidirectional composites; tension, compression, flexure and shear	9	20MEE562.3 20MEE562.6
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	20MEE562.3 20MEE562.4
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	20MEE562.5

Assessment Pattern

CIE (50 Marks – Theory)

Bloom's Category	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5		
Understand	2	5	5
Apply	8	5	5
Analyze	7	5	
Evaluate	3		
Create			

SEE (50 Marks – Theory)

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

Course Code	20MEE563		Credits	03
L: T: P:S	3:0:0:0		CIE Marks	50
Exams Hours	03		SEE Marks	50

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

20MEE563.1	**The usage, knowledge, skill and competence** in the use of basic concepts of Fluid Mechanics and thermodynamics to conceptualize working of Refrigeration and air conditioning system components.
20MEE563.2	**Examine methodically** and in detail of refrigeration and air conditioning system performance using standards.
20MEE563.3	**Ascertain or establish** various equipment sizing using psychometry calculation.
20MEE563.4	**Apply appropriate engineering techniques/methods** of cooling load calculations for different air conditioning systems based on various applications.
20MEE563.5	**The systematic process of developing a design** of central air conditioning systems by applying the knowledge to practical engineering problems as transmission and distribution of air.
20MEE563.6	**The systematic process of developing a design** 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	PO11	PO12	PSO1	PSO2
20MEE563.1	1													2
20MEE563.2		2												2
20MEE563.3			3											2
20MEE563.4					2									2
20MEE563.5			3	2										2
20MEE563.6			3	2										2

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

TEXT BOOKS:
1) Harry Peck, "Designing for Manufacturing", Pitman Publications, 2017, ISBN-13: 978-0273000075
2) A K Chitale, RC Gupta, "Product Design and Manufacturing", PHI, 2014, ISBN-13: 978-8120348738

REFERENCE BOOKS:
1) ASM Hand book, "Material selection and Design", Vol. 20, 2012, ISBN-13: 978-0871703866
2) C.M. Creveling, "Tolerance Design – A handbook for Developing Optimal Specifications", Addison – Wesley, 2013, ISBN-13: 978-0133052343
3) James G. Bralla, "Handbook of Product Design for Manufacturing", McGraw Hill, 2014, ISBN-13: 978-0070071308
4) Kevien Otto and Kristin Wood, "Product Design", Pearson Publication, 2012, ISBN-13:978-8177588217

Module No	Module Contents	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	20MEE563.1
2	**Multi Pressure Vapor Compression Systems: Multistage** 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 Types of Cooling towers, Analytical and graphical design procedures, Tower Characteristics, Parametric analysis.	10	20MEE563.2 20MEE563.3
3	**Vapour compression refrigeration equipment's.** 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	20MEE563.4
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	20MEE563.5
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 Equipment's: High pressure and low pressure cut out, thermostats, pilot operated solenoid valve, motor controls, bypass control- Damper motor.	6	20MEE563.6

Assessment Pattern

CIE (50 Marks – Theory)

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

SEE (50 Marks – Theory)

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

<h1 style="text-align:center; color:red;">SMART MATERIALS</h1>

Course Code	20MEE564		Credits	03
L: T: P:S	3:0:0:0		CIE Marks	50
Exams Hours	03		SEE Marks	50

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

20MEE564.1	Gain the knowledge on the characteristics of materials such as Metals, Polymers and Ceramics.
20MEE564.2	Analyze the characteristics of Electro, Magneto Rheological fluids and Chromic materials for various mechanical systems.
20MEE564.3	Apply the Electro strictive and Magneto strictive materials in the design of different materials.
20MEE564.4	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.
20MEE564.5	Custom and build the smart materials towards the development of smart composites.
20MEE564.6	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
20MEE564.1	3													
20MEE564.2	3	2												3
20MEE564.3	3		3	1										3
20MEE564.4	3					1	1							
20MEE564.5	3		3										1	
20MEE564.6	3	2												3

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

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 UniversityPress, 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)

Module No	Module Contents	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	20MEE564.1 20MEE564.2
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	20MEE564.2
3	**Piezoelectric Materials**: Piezoelectric properties, piezoelectric materials. Making of piezoelectric actuators. Inchworm linear motor and application of piezo - actuators for precision movement control. Piezo resistors as sensors. Magneto strictive materials. Magneto strictive actuators**.**	9	20MEE564.3
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, piezo chromic materials and their applications.	9	20MEE564.4
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	20MEE564.5 20MEE564.6

Assessment Pattern

CIE (50 Marks – Theory)

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

SEE (50 Marks – Theory)

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

THEORY OF ELASTICITY

Course Code	20MEE565		Credits	03
L: T: P:S	3:0:0:0		CIE Marks	50
Exams Hours	03		SEE Marks	50

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

20MEE565.1	Understand Generalized Hooke's Law to analytically approach the strength and deformation related problems of various structures.
20MEE565.2	Analyze elastic deformation problems for homogeneous isotropic materials and anisotropic materials which are the basis of mechanical engineering design.
20MEE565.3	Apply the compatibility equations to solve 2D Static loading problems in Cartesian and polar coordinate systems.
20MEE565.4	Visualise the transition to plastic deformation from elastic deformation.
20MEE565.5	Evaluate the behavioral effect of temperature on thermo elastic materials
20MEE565.6	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
20MEE565.1	3	3	2											3
20MEE565.2	3	3		3										3
20MEE565.3	3	3		3										3
20MEE565.4	3	3		3										3
20MEE565.5	3	3	2	3										3
20MEE565.6	3	3		3										3

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

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

REFERENCE BOOKS:
1) Theory of Elasticity, Dr. Sadhu Singh, Khanna Publications, 4th Ed, ISBN: 978-81-7409-060- 6
2) Elasticity, Theory, Applications & Numerical, 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

Module No	Module Contents	Hrs	COs
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	20MEE565.1
2	**TWO DIMENSIONAL PROBLEMS IN CARTESIAN COORDINATE SYSTEM:** Plain stress and plain strain, relation between plain stress and plain strain, Airy's stress functions. 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	20MEE565.2
3	**TWO DIMENSIONAL PROBLEMS IN POLAR COORDINATE SYSTEM**: Airy's stress functions. 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	20MEE565.3
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	20MEE565.4 20MEE565.6
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	20MEE565.5

Assessment Pattern

CIE (50 Marks – Theory)

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

Course Code	20MEE566
L: T: P:S	3:0:0:0
Exams Hours	03

Credits	03
CIE Marks	50
SEE Marks	50

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

20MEE566.1	Understand the fundamentals of software Testing and Software Testing Tools.
20MEE566.2	Apply the concept of Embedded System for its Software development.
20MEE566.3	Analyze the Linux operating system and Wi-Fi for raspberry pi.
20MEE566.4	Enable to configure various Sensors and Actuators, Memory, CommunicationInterface I2C
20MEE566.5	Discuss the Architecture and features of Raspberry Pi and become familiar with the design aspects of I/O and Memory Interfacing circuits.
20MEE566.6	Use modern tools to acquire competency in various storage devices and apply the knowledge gained in designing websites.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE566.1	3	3	3										2	
20MEE566.2	3	3	3										2	
20MEE566.3	3	3	3										2	
20MEE566.4	3	3	3										2	
20MEE566.5	3	3	3										2	
20MEE566.6	3	3	3										2	

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

TEXT BOOKS:
1) Introduction to Embedded Systems, Shibu K V, 2009, TMH.
2) Embedded Systems – A contemporary Design Tool, James K Peckol, 2014, John Wiley.

REFERENCE BOOKS:
1) Microprocessors and Interfacing – Programming & Hardware Douglas Hall, 2nd edition, 1990, McGraw Hill.
2) Microprocessors and Microcontrollers: Architecture, Programming and System Design, Krishna Kant, 2007, PHI.
3) The Intel Microprocessors Architecture, Programming and Interfacing, Barry B. Brey, 2007, Pearson Education.

Module No	Module Contents	Hrs	COs
1	**Agile/Scrum Methodology & Application Software Testing:** Agile Software Development, Fundamental Agile Testing Principles,Practices, and Processes, Agile Testing Methods, Techniques, and Tools, Test case design Techniques, Testing Methods, WEB testing,Software Testing Tools	8	20MEE566.1
2	**Introduction to Embedded Systems and Embedded OS:** Embedded System its importance, Embedded Systems Vs. General Computing Systems, Classification of Embedded System, Major Application areas of Embedded System, Purpose of Embedded System,and The Innovative Bonding of lifestyle with Embedded Technology, CISC vs. RISC, fundamentals of Von-Neumann/Harvard architectures, types of microcontrollers, selection of microcontrollers **OS installation & Setting up Wi-Fi for raspberry pi :** Download of Linux OS Latest version, installation, and partitioning, Embedded development environment - GNU debugger - tracing & profiling tools - binary utilities - kernel debugging - debugging embedded Linux applications - porting Linux - Linux and real time - SDRAM interface Wireless connection using Wi-Fi for raspberry pi.	9	20MEE566.2 20MEE566.3
3	**I/O & Serial protocol programming for Embedded development** Core of the Embedded System, Sensors and Actuators, Memory, Communication Interface, Embedded Firmware, Other SystemComponents Characteristics and Quality Attributes of Embedded Systems: Characteristics of an embedded system, quality attributes ofembedded system **Understanding I2C and I2C Interface ,programmingI2C** Understanding of serial communication protocol I2C, Details of sensors and actuator using I2C protocol, APIs to configure the I2C module on raspberry-pi and communicate to other devices over I2C,Programming the GPIO and interfacing peripherals With Raspberry Pi, Boot Process of Raspberry-Pi	9	20MEE566.4
4	**Introduction to single board computer:** Types of Processors, Advantages and Applications of Raspberry Pi. Introduction to Embedded Software Development, Compiling the applications, software flow, input, output and peripheral accesses,Microcontroller interfaces, Raspberry Pi board and its Data Sheet, , Client-Server programming **Hands-on with the Raspberry Pi 3 Model:** Raspberry Pi board data sheet, Using libcurl(for JSON objects),Boot Process of Raspberry-Pi, Client-Server programming	9	20MEE566.5
5	**Single board computer and peripherals interfacing:** Lego Train's IR protocol("LPF RC Protocol": LEGO Power Function RC Protocol),I2C GPIO expander board(using MCP23017),I2C GPIO Expander IC MCP23017/MCP23S17,Sample code to use I2C GPIO Expander, Understanding Stepper Motor, Using LDR Sensor Module with Raspberry Pi,BCM2835-ARM-Peripherals,BCM-2835 SOC details, Generating PWM signals through the Pi	9	20MEE566.6

Assessment Pattern

CIE (50 Marks – Theory)

Bloom's Category	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember			
Understand	5		
Apply	15	10	5
Analyze	3	3	3
Evaluate	2		
Create		3	2

SEE (50 Marks – Theory)

Bloom's Category	Tests (theory)
Remember	
Understand	5
Apply	30
Analyze	5
Evaluate	5
Create	5

MACHINE THEORY & MECHANISM DESIGN LAB

Course Code	20MEL51
L: T: P:S	0:0:1:0
Exams Hours	03

Credits	01
CIE Marks	25
SEE Marks	25

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

20MEL51.1	Synthesis the Inversions of mechanisms for different motion transfer scenarios.
20MEL51.2	Analyze the velocity and acceleration of mechanisms and machines in operating conditions.
20MEL51.3	Determine the causes and solutions for Unbalance in rotary components of different machines.
20MEL51.4	Apply the Principles of statics and dynamics in understanding the behavior of machines andmechanisms.
20MEL51.5	Illustrate the inertial parameters and variables which affect the performance of Governors.
20MEL51.6	Investigate the effects of Gyroscopic couple on different applications involving Prime movers.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEL51.1	3		3										3	
20MEL51.2	3	3		1										3
20MEL51.3														3
20MEL51.4		3	3											3
20MEL51.5	3												3	3
20MEL51.6	3	3												3

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

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

Exp. No.	Contents of Experiment	Hrs	COs
1	Synthesis and simulation of 4 bar mechanism using multi-body dynamics software.	3	20MEL51.1
2	Synthesis and simulation of Inversions of 4 bar mechanism using multi-body dynamics software.	3	20MEL51.1
3	Synthesis and simulation of Slider crank Chain using multi-body dynamics software.	3	20MEL51.1
4	Synthesis and simulation of Inversions of Slider crank Chain using multi-body dynamics software.	3	20MEL51.1
5	Velocity and acceleration analysis of 4 bar mechanism and its inversions by using Graphical method in solid edge.	3	20MEL51.2 20MEL51.4
6	Velocity and Acceleration analysis of slider crank chain and its inversions using graphical method in solid edge.	3	20MEL51.2 20MEL51.4
7	Balancing of rotating masses in same plane using graphical Method in Solid edge.	3	20MEL51.3 20MEL51.4
8	Balancing of rotating masses in different planes using graphical method in solid edge.	3	20MEL51.3 20MEL51.4
9	Determination of Sensitiveness and Controlling force of a Porter Governor.	3	20MEL51.5
10	Demonstration on Practical applications of gyroscopic couple.	3	20MEL51.6
11	Demonstration on Practical applications of flywheel, gear train and cam follower.	3	20MEL51.4

Assessment Pattern

CIE (25 Marks – Lab)

Bloom's Category	Experiments / Tests	Record	Viva
Marks	10	10	5
Remember			1
Understand			1
Apply		3	1
Analyze	5	3	1
Evaluate	5	4	1
Create			

SEE (25 Marks – Lab)

Bloom's Category	Test
Remember	5
Understand	5
Apply	5
Analyze	5
Evaluate	5
Create	

HEAT POWER CYCLES LAB

Course Code	20MEL52		Credits	01
L: T: P:S	0:0:1:0		CIE Marks	25
Exams Hours	03		SEE Marks	25

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

20MEL52.1	Identify the working of petrol and diesel engines and to develop heat balance sheet.
20MEL52.2	Apply the first and second law of thermodynamics to gas turbines and IC Engines to obtain efficiencies.
20MEL52.3	Describe the characteristics of gas power, vapor power & Brayton cycles and investigate ways to increase the thermal efficiency
20MEL52.4	Development of enhanced thermal systems by minimizing the constraints which enables the student to have continuous learning
20MEL52.5	Evaluate the performance of various refrigeration cycles and review factors involved in selection of right refrigerant for an application.
20MEL52.6	Use the psychrometric chart as a tool to determine the properties of atmospheric air.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEL52.1	3	2												
20MEL52.2	3	2												
20MEL52.3	3		1	1										3
20MEL52.4	3								1			1		3
20MEL52.5	3						2							3
20MEL52.6	3				1		2							3

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

TEXT BOOKS:
1) Applied Thermodynamics By R.K.Rajput , Lakmi Publications Ltd., 2ndEd,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

Exp. No.	Contents of Experiment	Hrs	COs
1	Valve Timing/port opening diagram of an I.C. engine (4 stroke/2stroke).	3	20MEL52.1
2	Performance Tests on I.C. Engines(multi cylinder diesel), Calculations of IP, BP, Thermal efficiencies, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:FRatio heat balance sheet for Four stroke Diesel Engine, Morse test all the graphs using open source tool.	3	20MEL52.1
3	Planimeter, flash point and fire point (open & closed)	3	20MEL52.2
4	Performance Tests on I.C. Engines,(single cylinder diesel) Calculations of IP, BP, Thermal efficiencies, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F Ratio for Four stroke Diesel Engine	3	20MEL52.2
5	Determination of Calorific value of solid, liquid and gaseous fuels	3	20MEL52.3
6	Performance Test on a Vapour Compression Refrigeration	3	20MEL52.5
7	Determination of property values for common refrigerants	6	20MEL52.5
8	Performance Test on a Vapour Compression Air – Conditioner	3	20MEL52.6
9	Duct design for different air conditioning system	3	20MEL52.6

Assessment Pattern

CIE (25 Marks – Lab)

Bloom's Category	Experiments / Tests	Record	Viva
Marks	**10**	**10**	**5**
Remember			1
Understand			1
Apply		3	1
Analyze	5	3	1
Evaluate	5	4	1
Create			

SEE (25 Marks – Lab)

Bloom's Category	Test
Remember	5
Understand	5
Apply	5
Analyze	5
Evaluate	5
Create	

ROTOR DYNAMICS LAB

Course Code	20MEL53		Credits	01
L: T: P:S	0:0:1:0		CIE Marks	25
Exams Hours	03		SEE Marks	25

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

20MEL53.1	**Apply basic concepts of Fluid Mechanics to conceptualize the impact of Jet** on different shapes of vanes
20MEL53.2	**Analyze** the performance characteristics of turbo machines
20MEL53.3	**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
20MEL53.4	**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
20MEL53.1	3	3	3	3	3								3	
20MEL53.2	3	3	3	3	3								3	
20MEL53.3		3							2	2				
20MEL53.4	3		3	3								1		

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

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.

Exp. No.	Contents of Experiment	Hrs	COs
1	To determine the impact of jet on hemispherical vanes	3	20MEL53.1
2	To determine the impact of jet on Flat plate	3	20MEL53.1
3	To determine the impact of jet on inclined surface	3	20MEL53.1
4	To determine the performance characteristics of reciprocating pump – Constant Head	3	20MEL53.2 20MEL53.3
5	To determine the performance characteristics of reciprocating pump – Constant Speed	3	20MEL53.2 20MEL53.3
6	To determine the performance characteristics of Single stage centrifugalpump	3	20MEL53.2 20MEL53.3
7	To determine the efficiency of air blower	3	20MEL53.2 20MEL53.3
8	To determine the performance characteristics of multi stage air compressor	3	20MEL53.2 20MEL53.3
9	To determine the performance characteristics of Multi stage centrifugal pump – Constant Speed	3	20MEL53.2 20MEL53.3
10	To Find the performance test on Pelton Wheel	3	20MEL53.2 20MEL53.3 20MEL53.4
11	To Find the performance test on Francis turbine	3	20MEL53.2 20MEL53.3 20MEL53.4

Assessment Pattern

CIE (25 Marks – Lab)

Bloom's Category	Experiments / Tests	Record	Viva
Marks	**10**	**10**	**5**
Remember			1
Understand			1
Apply		3	1
Analyze	5	3	1
Evaluate	5	4	1
Create			

SEE (25 Marks – Lab)

Bloom's Category	Test
Remember	5
Understand	5
Apply	5
Analyze	5
Evaluate	5
Create	

SIXTH SEMESTER SYLLABUS

FUNDAMENTALS OF HEAT TRANSFER

Course Code	20MEE61		Credits	03
L: T: P:S	2:1:0:0		CIE Marks	50
Exams Hours	03		SEE Marks	50

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

20MEE61.1	Apply heat transfer principles to design and evaluate the performance of thermal systems in order to minimize the heat loss
20MEE61.2	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
20MEE61.3	Design and apply the concepts of radiation shield system in preventing harmful radiations inpower plants.
20MEE61.4	Development of enhanced thermal systems as a team by minimizing the constraints whichenables the student to have continuous learning
20MEE61.5	Analyze the complex engineering problems in convection heat transfer and also use computational tools to design heat exchangers.
20MEE61.6	Design and develop the eco friendly Condensing and heat exchange equipments 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
20MEE61.1	3		3											
20MEE61.2	3	3	3											
20MEE61.3	3		3			1	2							3
20MEE61.4	3													
20MEE61.5	3	3			2									3
20MEE61.6	3		3				2							3

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

TEXT BOOKS:
1) Engineering Heat & Mass transfer, Mahesh M Rathor, University Science PressLakshmi 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 sons, 7th Ed, ISBN : 978-1-118-37924-0
4) Heat transfer-A basic approach, Ozisik, Tata McGraw Hill 2002.

Module No	Module Contents	Hrs	COs
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 equation in rectangular, cylindrical and spherical coordinates for plane and composite walls (No 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	8	20MEE61.1 20MEE61.6
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. Computational Heat Transfer: Finite Difference Formulation of Differential Equations, 1D steady state heat conduction, boundary conditions and analysis. 2D steady state heat transfer, boundary nodes, irregular boundaries. Transient heat conduction in plane wall.	9	20MEE61.2 20MEE61.6
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.	9	20MEE61.3 20MEE61.5 20MEE61.6
4	**Radiation Heat Transfer**: Thermal radiation; definitions of various terms used in radiation heat transfer. Basic Laws: Stefan-Boltzmann law, Kirchoff's law, Planck's law and Wein's displacement law, Lambert's law. Radiation Intensity, Solid angle, Spectral Quantities, Radiosity. 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 configuration factor and view factor, View Factor Relations. Numerical problems.	9	20MEE61.2 20MEE61.6
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.	9	20MEE61.4 20MEE61.6

Assessment Pattern

CIE (50 Marks – Theory)

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

SEE (50 Marks – Theory)

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

FINITE ELEMENT METHODS

Course Code	20MEE62		Credits	03
L: T: P:S	2:1:0:0		CIE Marks	50
Exams Hours	03		SEE Marks	50

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

20MEE62.1	Understand the concept of FEM, FE procedure, Interpolations, paraphrase numerical methods.
20MEE62.2	Evaluate the stress and desirable characteristics of one dimensional element.
20MEE62.3	Analyze the problem for applying boundary conditions for 2-D elements
20MEE62.4	Implement the formulation techniques to solve two-dimensional problems using triangle and quadrilateral elements.
20MEE62.5	Able to apply suitable boundary conditions to a global equation for trusses and beams.
20MEE62.6	Evaluate dynamics problems using FEM and Eigen values given applications

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE62.1	3	3	3	3										3
20MEE62.2	3	3	3	3										3
20MEE62.3	3	3	3	3										3
20MEE62.4	3	3	3	3										3
20MEE62.5	3	3	3	3										3
20MEE62.6	3	3	3	3										3

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

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

Module No	Module Contents	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.	9	20MEE62.1
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	9	20MEE62.2
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	20MEE62.3 20MEE62.4
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	20MEE62.5
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	20MEE62.6

Assessment Pattern

CIE (50 Marks – Theory)

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

SEE (50 Marks – Theory)

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

DESIGN OF MACHINE ELEMENTS-II

Course Code	20MEE63		Credits	04
L: T: P:S	3:1:0:0		CIE Marks	50
Exams Hours	03		SEE Marks	50

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

20MEE63.1	Analyze the stresses included in the curved beams, cylinder and cylinder heads using designstandards.
20MEE63.2	Design ropes, chains, and springs with the aid of design data handbook.
20MEE63.3	Gain knowledge on surface failure subjected to different types of wear.
20MEE63.4	Realize the importance of lubricants and their properties towards the design of bearing elements.
20MEE63.5	Recommend the adequate surface hardness for bevel and worm gears with detailed design subjected to static and dynamic loading conditions.
20MEE63.6	Design different types of cutches 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
20MEE63.1	3	3	3	3										3
20MEE63.2	3	3	3	3										3
20MEE63.3	3	3	3	3										3
20MEE63.4	3	3	3	3										3
20MEE63.5	3	3	3	3										3
20MEE63.6	3	3	3	3										3

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

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

REFERENCE 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.

Module No	Module Contents	Hrs	COs
1	**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	**20MEE63.1** **20MEE63.6**
2	**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.	10	**20MEE63.3** **20MEE63.6**
3	**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 design.	8	**20MEE63.1** **20MEE63.6**
4	**Bevel Gears**: Definitions, formative number of teeth, Design based onstrength, dynamic and wear loads. **Worm Gears**: Definitions, Design based on strength, dynamic, wear loads and efficiency of worm gear drives.	8	**20MEE63.2** **20MEE63.5** **20MEE63.6**
5	**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	**20MEE63.4** **20MEE63.6**

Assessment Pattern

CIE (50 Marks – Theory)

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

FUNDAMENTALS OF TRIBOLOGY

Course Code	20MEE641	Credits	03
L: T: P:S	3:0:0:0	CIE Marks	50
Exams Hours	03	SEE Marks	50

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

20MEE641.1	Understand the basics of Tribology, Wear mechanism & Friction
20MEE641.2	Evaluate Hagen's Poiseuille's theory & Reynolds's equation
20MEE641.3	Analyze the characteristics of idealized journal bearing and slider bearings.
20MEE641.4	Apply the concepts of Hydrostatic Lubrication and Hydrodynamic Lubrication
20MEE641.5	Remember the laws of friction with respect to bearings.
20MEE641.6	Know the different types and properties of bearing materials and Characterize the behavior of Tribological components

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE641.1		3					3							3
20MEE641.2	3												3	
20MEE641.3		3		1										3
20MEE641.4	3												3	3
20MEE641.5													3	
20MEE641.6	3					1	3						3	

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

TEXT BOOKS:
1) Fundamentals of Tribology , Basu S K., Sengupta A N., Ahuja B. B., , PHI 2013, ISBN- 13: 978-8120327238
2) Introduction to Tribology Bearings, Mujumdar B. C., S. Chand company pvt. Ltd,2010, ISBN-13: 978-8121929875
3) Lubrication of bearings – Theoretical Principles and Design, Redzimovskay E I., Oxford press company 2013, ISBN-13: 978-1461270607
4) Design data hand book, volume-II, Prof. KLINGAIAH, Suma publications,8th edition- 2006.

REFERENCE BOOKS:
1) Principles and Applications of Tribology, Moore, Pergamaon press 2013, ASIN: B01DDMZB3W
2) Tribology, R Suresh Kumar, Subhas Stores Publications, 2016
3) Tribology in Industries, Srivastava S., S Chand and Company limited, Delhi 2011, ISBN-13: 978-8121920452
4) Theory and Practice of Lubrication for Engineers, Fuller, D., New York company 1998, ISBN-13: 978-0471047032

Module No	Module Contents	Hrs	COs
1	**Introduction:** Bearings, Friction, Wear and its phenomena ,Lubrication, Boundary Lubrication, Film Lubrication, AbsoluteViscosity, Newton's Law of viscosity, Hagen- Poiseuille's Law, Flow between parallel stationary planes, viscosity measuring apparatus. Lubrication principles, classification of lubricants. **surface interaction and friction**: Topography of Surfaces –Surface features-Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction ––Thermal considerations in sliding contact.	9	**20MEE641.1 20MEE641.2**
2	**Idealized Journal Bearing:** Introduction to idealized journal bearing, load carrying capacity, condition for equilibrium, Sommerfeld's numbers and significance of it; numerical problems. **Slider / Pad Bearing With A Fixed Shoe:** Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a pivoted shoe bearing, numerical examples	9	**20MEE641.3**
3	**Hydrodynamic Lubrication**: Friction forces and power loss in lightly loaded bearing, Petroff's law, Tower's experiments, numerical, mechanism of pressure development in an oil film, Reynold's equation in 2D.	9	**20MEE641.4**
4	**Friction:** Laws of friction - Stick-slip phenomenon- Friction characteristics of metals and non-metals - Adhesion andPloughing theory of friction **Antifriction Bearings:** Introduction, Advantages and selection of Bearings, Selection Procedure, life rating of Antifriction Bearings, Rigidly and load on Roller bearing supported units, Load bearing capacity, Preloaded bearings, Radial and Axial Rigidity of spindle supports for varioustypes.	9	**20MEE641.5**
5	**Bearing Materials:** Commonly used bearings materials, properties of typical bearing materials. Advantages and disadvantages of bearing materials **Behaviour of Tribological Components:** Selection of bearings, Plain bearings, Gears, Wire ropes, Seals and packings, Conveyor belts, Wear of ceramic materials, wear measurements,effects of speed, temperature and pressure.	9	**20MEE641.5 20MEE641.6**

Assessment Pattern

CIE (50 Marks – Theory)

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

COMPUTER GRAPHICS

Course Code	20MEE642
L: T: P:S	3:0:0:0
Exams Hours	03

Credits	03
CIE Marks	50
SEE Marks	50

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

20MEE642.1	Analyze the concept of scan conversion & clipping representation
20MEE642.2	Demonstrate Two dimensional & three-dimensional transformations
20MEE642.3	Describe plane curves, space curves and mathematical representations of solids
20MEE642.4	Create the visual realism for planes and solid objects
20MEE642.5	Develop computer animation for engineering and entertainment applications.
20MEE642.6	Apply knowledge gained to practical applications in engineering

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE642.1	3	2												3
20MEE642.2	3		3											3
20MEE642.3	3	2	3											3
20MEE642.4	3			1										3
20MEE642.5	3				1									3
20MEE642.6	3					1						1		3

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

TEXT BOOKS:
1) Mathematical Elements for Computer Graphics, David Rogers, J. Alan Adams McGraw Hill. 2017, ISBN-13: 978-0070535275
2) CAD/CAM-Theory and Practice, Ibraham Zeid, R. Siva Subramanian , McGraw Hill, 2010, ISBN-13: 978-0070151345

REFERENCE BOOKS:
1) Computer Graphics, Xiang z, Plastock, R. A., Schaums outlines, 2nd Edition, McGraw Hill. 2015, ISBN-13:978-0070601659
2) Computer Graphics, principles and practice, .Foley, Van- Damn, Finner and Hughes, Addison Wesley, 3rd Edition. 2014, ISBN-13:978-0321399526
3) Computer Graphics, Sinha A. N., Udai A. D., Tata McGraw Hill, 2014, ISBN- 13:978- 0070634374
4) Computer Graphics, Steven Harrington, 2nd Edition McGraw Hill, 2014, ISBN- 13:978- 0071004725

Module No	Module Contents	Hrs	COs
1	**Scan Conversion and Clipping Representation** of points, lines, Line Drawing Algorithms: DDA algorithm, Bresenham's integer line algorithm, Bresenham's circle algorithm, midpoint line and circle, Polygon filling algorithms: scan conversion, seed filling, scan line algorithm. Viewing transformation, Clipping –points, lines, text, polygon, Cohen-Sutherland line clipping, Sutherland-Hodgmen algorithm.	8	20MEE642.1
2	**Two Dimensional Transformations** Representation of points, Transformations: Rotation, Reflection, Scaling, Combined Transformations, Translations and Homogeneous Coordinates, A geometric interpretation of homogeneous coordinates, Over all scaling, Points at infinity, rotation about an arbitrary point, Reflection through an arbitrary line. **Three Dimensional Transformations** and Projections 3D Transformation matrix: general matrix, Translation, scaling, Shearing, Rotation, Reflection, Multiple transformations, Rotation about an axis parallel to coordinate axis, Rotation about an arbitrary axis in space, Reflection through an arbitrary plane, Orthographic, Parallel projection Transformations, one, Perspective projections- one point, two point and three point.	9	20MEE642.2
3	**Plane and Space Curves** Curve representation, Nonparametric curves, parametric curves, parametric representation and generation of line, circle, ellipse, parabola, hyperbola, generation of circle, ellipse, parabola, hyperbola, Cubic spline, normalized cubic splines, Bezier curves: blending function, properties, generation, B- spline curves-Cox-deBoor recursive formula, properties, open uniform basis functions, Non-uniform basis functions, periodic B- spline curve. **Types and Mathematical Representation** of Solids, Solid Models, Solid entities, Solid representation, Solid modeling- set theory, regularized set operations, set membership classification, Half spaces, Half spaces of plane, cylinder, sphere, conical half-space, Boundary representation, Constructive Solid Geometry- basic elements, Building operations.	9	20MEE642.3
4	**Visual Realism-I**: Introduction, hidden line removal- visibility of object views, Visibility techniques: minimax test, containment test, surface test, Silhouttes, Homogeneity test, Sorting, Coherence, Hidden line priority algorithm, Hidden surface removal- Z-buffer algorithm, Warnock's algorithm, Hidden solid removal- ray tracing algorithm. **Visual Realism-II**: Shading, shading models- diffuse reflection, specular reflection, ambient light, Shading surfaces- constant shading, gourmand shading, Phong shading, Shading enhancements, Shading Solids- Ray tracing for CSG, z- buffer algorithm for B-rep and CSG, octree encoded objects, Colouring- RGB, CMY, HSV, HSL colour models.	9	20MEE642.4
5	**Computer Animation:** Introduction, Conventional animation-key frame, Inbetweening, Line testing, Painting, Filming, Computer animation entertainment and engineering animation, Animation system hardware, software architecture, Animation types- frame buffer, colour table, zoompan- scroll, cross bar, real time play back, Animation techniques-key frame, skeleton. Path of motion and p-curves.	8	20MEE642.5 20MEE642.6

Assessment Pattern

CIE (50 Marks – Theory)

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

FUNDAMENTALS OF PLASTIC MOLD DESIGN AND DIE DESIGN

Course Code	20MEE643		Credits	03
L: T: P:S	3:0:0:0		CIE Marks	50
Exams Hours	03		SEE Marks	50

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

20MEE643.1	Understand the basics concepts of Injection mold design
20MEE643.2	Apply knowledge in Compression mold design
20MEE643.3	Understand the casting techniques and the essential parts for the design of moulds
20MEE643.4	Remember the fundamentals of press tool design.
20MEE643.5	Analyze basics of pressure die casting, forging die design, extrusion dies and rollingdies
20MEE643.6	Apply the knowledge gained to practical applications.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE643.1	3	2	2								2			
20MEE643.2	3	2	2								2			
20MEE643.3	3	2	2								2			
20MEE643.4	3	2	2								2			
20MEE643.5	3	2	2								2			
20MEE643.6	3	2	2								2			

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

TEXT BOOKS:
1) Injection mold design engineering, David O Kazmer, 2nd edition 2016, Hanser publications.
2) Fundamentals of Plastics Mould Design- Sanjay K Nayak , Pratap Chandra Padhi,
3) Y. Hidayathullah, Publication Tata McGraw Hill Education Private Limited ,2012
4) Injection Mould Design : An Introduction And Design For The Thermoplastics Industry by Pye R G W (Author). Publisher: Affiliated East-West Press Pvt. Ltd. (2000)

REFERENCE BOOKS:
1) Complete Casting Handbook,2ndEdition,Metal Casting Processes,
2) Metallurgy, Techniques and Design, Authors: John Campbell, Imprint: Butterworth- Heinemann, Published Date: 25th August 2015.
3) Fundamentals of Die Casting Design, by Genick Bar-Meir, Ph.D, 2009.
4) Press Tools Design and Construction, 2012, by Joshi P.H. (Author), S. Chand and publications.
5) A Textbook of Production Engineering, 11/e, by P.C. Sharma, S. Chand Publishing, 2010.
6) Tool Engineering and design by G.R. Nagpal., Khanna Publishers,2013 edition.

Module No	Module Contents	Hrs	COs
1	**Injection Mold Design:** Plastics product design Concepts Essential factors Principles Methodical approach -process variables v/s product design. Uniform and symmetrical wall thickness Draft angle Rib design Fillets & Radius Bosses Holes Threads standard thread forms undercuts Hinges metal inserts parting line Tolerances **General mold construction** : Introduction , Mold design concepts - mold elements parting line and parting surface construction of core and cavities Bolsters mold alignment, Feed system sprue, runner, gate & position of gate runner & gate balancing, Ejection types of ejections mold cooling venting- ancillary parts and split mold	8	20MEE643.1
2	**Compression Mold Design** : Types of compression mold, openflash, semi-positive type, positive, displacement molds, types of loading chambers, bulk factor, flash thickness, pot design, projected area, compression pressure, clamping force, no. of impression by technological method, heating system, types of heaters, heat loss, heat requirement & heater capacity.	9	20MEE643.2
3	**Design of molds for castings:** Introduction: Classification of Castings, Sand casting, Metal mold castings, Plastic molds casting, Investment casting, Gravity die casting, Pressure die casting, Advantages of Die casting, Die casting process, vacuum casting. Die Casting Alloys Low fusion alloys, High fusion alloys, Properties Simple problems.	9	20MEE643.3
4	**Press tool design**: types of presses, types of dies, Clearance, die sets, materials of die sets, cutting force, die block design, punch design, punch holder and die support, stripper plate, die springs, die wear, blanking die design. Introduction to bending, forming and drawing dies. Simple problems.	9	20MEE643.4
5	**Introduction to pressure die casting, forging, extrusion and rolling die design:** Die Casting die design: Hot chamber machine, cold chamber machine, Horizontal machine, Vertical machine, Die locking, Toggle locking, Hydraulic locking, Injection systems, knock out pins and plates, ejector system furnaces, loading of metal into hot chamber-.Forging dies, parts, upset forging, trimming, design of forging dies,- introduction to extrusion die and rolling die design. Industrial applications of above.	9	20MEE643.5 20MEE643.6

Assessment Pattern

CIE (50 Marks – Theory)

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

EMERGING AUTOMOTIVE TECHNOLOGIES

Course Code	20MEE644		Credits	03
L: T: P:S	3:0:0:0		CIE Marks	50
Exams Hours	03		SEE Marks	50

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

20MEE644.1	Understand the functions of IC engine components and fuel supply systems.
20MEE644.2	Investigation of the Super and Turbo Chargers for enhancing the power output.
20MEE644.3	Study of the different ignition systems used in IC engines.
20MEE644.4	Design and Development of various transmission system, braking and safety Mechanisms.
20MEE644.5	Analyze the concept of Electric Vehicles, Energy Storage and Automotive Emission Control System.
20MEE644.6	Implement the Automotive Applications for Modern Technology.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE644.1	2												2	
20MEE644.2		2												3
20MEE644.3	2												2	
20MEE644.4			2											3
20MEE644.5		2												3
20MEE644.6		2												3

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

TEXT BOOKS:
1) Automotive mechanics, William H Crouse & Donald L Anglin, 10th Edition Tata McGraw Hill Publishing Company Ltd., 2007
2) Automotive Mechanics Srinivasan, 2nd Ed., Tata McGraw Hill 2003.

REFERENCE BOOKS:
1) Automotive mechanics: Principles and Practices, Joseph Heitner, D Van Nostrand Company, Inc
2) Fundamentals of Automobile Engineering, K.K.Ramalingam, Scitech Publications (India) Pvt. Ltd.
3) Automobile Engineering, R. B. Gupta, Satya Prakashan, 4th edn. 1984.
4) Automobile engineering, Kirpal Singh. Vol I and II 2002. 5.Internal combustion engines, V Ganesan

Module No	Module Contents	Hrs	COs
1	**Engine Components and Modern Fuel Supply Systems**: cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, Electronic Fuel Injection(EFI) system, merits and demerits of EFI system, multi-point fuel injection system , D-MPFI system, L-MPFI system, Common rail injection system, i-V TECH,VVT **Superchargers And Turbochargers**: Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger lag.	9	20MEE644.1
2	**Ignition Systems**: Battery Ignition systems, magneto Ignition system, Transistor assist contacts. Electronic Ignition, Automatic Ignition advance systems. **Power Trains**: Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Over drive, fluid flywheel, torque converter	9	20MEE644.2 20MEE644.3 20MEE644.5
3	**Drive To Wheels**: Propeller shaft and universal joints, differential, steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, condition for exact steering, steering gears, power steering, general arrangements of links and stub axle, over steer, under steer and neutral steer.	9	20MEE644.4
4	**Brakes**: Types of brakes, mechanical compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, Antilock – Braking systems **Automotive Emission Control Systems**: Controlling crankcase emissions, Controlling evaporative emissions, Exhaust gas recirculation, Catalytic converter, Treating the exhaust gas, Air- injection system, Air-aspirator system, Emission Standards : BS-I,BS-II, BS-III, BS-IV,BS-VI	9	20MEE644.4 20MEE644.5
5	**Introduction to Electric Vehicles**: Introduction to electric components used in electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives **Energy Storage:** Introduction to Energy Storage Requirements in Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices. Case Studies: Comparison between I C Engines and Electric Vehicles.	8	20MEE644.4 20MEE644.6

Assessment Pattern

CIE (50 Marks – Theory)

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

SEE (50 Marks – Theory)

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

ADVANCED ROBOTICS

Course Code	20MEE645		Credits	03
L: T: P:S	3:0:0:0		CIE Marks	50
Exams Hours	03		SEE Marks	50

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

20MEE645.1	Understand the history, classification, and fundamental concepts in robotic manipulation.
20MEE645.2	Analyze Kinematics and Dynamics of robots
20MEE645.3	Understand the concepts of velocity and statics of robots
20MEE645.4	Analyze trajectory planning methods in robotics systems.
20MEE645.5	Understand the different control techniques (linear and nonlinear) used for a robotic manipulator
20MEE645.6	Apply knowledge in robot programming methods and applications.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE645.1		3												
20MEE645.2		3												3
20MEE645.3		3												3
20MEE645.4		3	2		2									3
20MEE645.5		3												3
20MEE645.6	1		2		2									3

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

TEXT BOOKS:
1) "Industrial Robotics, Technology programming and Applications", Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, AshishDutta, McGraw Hill, 2012 ISBN- 13: 978-0071004428
2) "Introduction to Robotics: Analysis, Control, Applications", Saeed B Niku, Wiley 201, ISBN-13: 978-812653312
3) "Robotics and control" R Mittle, I Nagrath, McGraw Hill Education, 2017, ISBN-13: 978- 0070482937

REFERENCE BOOKS:
1) "Robotics Technology and Flexible Automation" S. R. Deb, Sankha Deb, McGraw Hill Education, 2017, ISBN-13: 978-0070077911
2) "Robotics: Fundamental Concepts and Analysis" AshitavaGhosal, Oxford, 2016, ISBN- 13: 978-0195673913
3) "Fundamentals of Robotics, Analysis and Control", Schilling R. J, Pearson Education India, 2015 ISBN-13: 978-9332555235

Module No	Module Contents	Hrs	COs
1	**Introduction** History of robots, Classification of robots, Present status and future trends. Basic components of robotic system. Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom. Mechanisms and transmission, End effectors, Grippers-different methods of gripping, Mechanical grippers- Slider crank mechanism, Screw type, Rotary actuators, Cam type gripper, Magnetic grippers, Vacuum grippers, Air operated grippers; Specifications of robot.	8	20MEE645.1
2	**Kinematics and Dynamics of Robots:** 2D, 3D Transformation, Scaling, Rotation, Translation, Homogeneous coordinates, multiple transformation, Simple problems. Matrix representation, Forward and Reverse Kinematics Of Three Degree of Freedom, Homogeneous Transformations, Inverse kinematics of Robot, Robot Arm dynamics, D-H representation of robots, Basics of Trajectory Planning	9	20MEE645.2
3	**Velocity and Static's of Manipulators:** Differential relationships, Jacobian, Differential motions of a frame (translation and rotation), Linear and angular velocity of a rigid body, Linear and angular velocities of links in serial manipulators, 2R, 3R manipulators, Jacobian of serial manipulator, Velocity ellipse of 2R manipulator, Singularities of 2R manipulators, Statics of serial manipulators, Static force and torque analysis of 3R manipulator, Singularity in force domain.	9	20MEE645.3
4	**Trajectory Planning:** Joint space schemes, cubic trajectory, Joint space schemes with via points, Cubic trajectory with a via point, Third order polynomial trajectory planning, Linear segments with parabolic blends, Cartesian space schemes, Cartesian straight line and circular motion planning.	9	20MEE645.3 20MEE645.4
5	**Robot Control, Programming and Applications**: Robot controls-Point to point control, Continuous path control, Intelligent robot, Control system for robot joint, Control actions, Feedback devices, Encoder, Resolver, LVDT , Motion Interpolations, Adaptive control. **Introduction to Robotic Programming:** On-line and off-line programming, programming examples. **Robot applications** -Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting.	9	20MEE645.5 20MEE645.6

Assessment Pattern

CIE (50 Marks – Theory)

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

SEE (50 Marks – Theory)

Bloom's Category	Tests (theory)
Remember	5
Understand	5
Apply	20
Analyze	15
Evaluate	5
Create	

NANO TECHNOLOGY

Course Code	20MEE651		Credits	03
L: T: P:S	3:0:0:0		CIE Marks	50
Exams Hours	03		SEE Marks	50

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

20MEE651.1	Understand characterization and properties which provide an overview of nanostructures evincing their fascinating properties unseen otherwise.
20MEE651.2	Analyse materials from nano to macro length scale, and its adoption in nature (bio mimicking) will also be emphasized.
20MEE651.3	Demonstrate the ability to read and analyze current engineering methodologies to determine various methods and techniques used in nano technology.
20MEE651.4	The student will demonstrate approaches to engineering nano materials and nano structures.
20MEE651.5	To learn about nano sensors and their applications in mechanical, electrical, electronic, magnetic, chemical field.
20MEE651.6	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
20MEE651.1	3												3	
20MEE651.2	3	3											3	
20MEE651.3	3	3											3	
20MEE651.4	3												3	
20MEE651.5	3	3											3	
20MEE651.6	3												3	

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

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

Module No	Module Contents	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, introduction to Nanobiology	8	20MEE651.1
2	**Novel properties of nano materials**-size and shape dependent optical, emission, electronic, transport, photonic, refractive index, mechanical, magnetic catalytic/photo catalytic properties.	9	20MEE651.2
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	20MEE651.3
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. Nano composites: Reinforcement in Ceramics, Drug delivery, Giant magneto resistance, etc. Cells response to Nanostructures.	9	20MEE651.3 20MEE651.4
5	**Thermodynamics of Nanomaterials, 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 nano biosensors 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	20MEE651.5 20MEE651.6

Assessment Pattern

CIE (50 Marks – Theory)

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

SEE (50 Marks – Theory)

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

FRACTURE MECHANICS

Course Code	20MEE652		Credits	03
L: T: P:S	3:0:0:0		CIE Marks	50
Exams Hours	03		SEE Marks	50

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

20MEE652.1	Apply the basic concepts of Fracture Mechanics in engineering design and manufacture forbrittle and ductile materials.
20MEE652.2	Acquire knowledge on different modes of crack propagation and analyze the plane stressand plane strain condition.
20MEE652.3	Investigate the difference between Linear Elastic Fracture Mechanics and Elastic Plastic Fracture Mechanics in the field of engineering. .
20MEE652.4	Design the different types of specimen for fatigue and fracture analysis.
20MEE652.5	Evaluate CTOD by using different methods of FM approach, and analyze by using analysissoftware.
20MEE652.6	Conduct investigations on various NDT methods to determine the fracture, crack and flawsin the materials.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE652.1	2													3
20MEE652.2	2	2												3
20MEE652.3		2		2										3
20MEE652.4			2											3
20MEE652.5			2		1									3
20MEE652.6				2									1	

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

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, Artinus Nijhoff, 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.

Module No	Module Contents	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	20MEE652.1 20MEE652.3 20MEE652.6
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	20MEE652.2 20MEE652.5
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	20MEE652.2 20MEE652.3 20MEE652.6
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	20MEE652.4 20MEE652.6
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	20MEE652.4 20MEE652.6

Assessment Pattern

CIE (50 Marks – Theory)

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

PRODUCT LIFE CYCLE MANAGEMENT

Course Code	20MEE653		Credits	03
L: T: P:S	3:0:0:0		CIE Marks	50
Exams Hours	03		SEE Marks	50

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

20MEE653.1	Integrate the various stages of PLM into engineering product categories and portfolios thatwill evaluate into commercial success.
20MEE653.2	Interpret the data with information and/or communicate the same for the supply chain and value supplier chain quotation to ensure sustainable development.
20MEE653.3	Examine life cycle management strategies and knowledge to develop new and/or appropriate engineering design solutions in engineering environment.
20MEE653.4	Translate and implement the legal, environmental and international regulatory frame works into product design, development and manufacturing requirements.
20MEE653.5	assess system for corrective and preventive action to track production Quality issues through digital manufacturing.
20MEE653.6	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
20MEE653.1	3		3										3	
20MEE653.2	3			1	3								3	
20MEE653.3	3		3						1				3	
20MEE653.4		2	3										3	
20MEE653.5					3								3	
20MEE653.6					3						1		3	

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

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",
4) Springer-Verlag, 2015. ISBN: 978-3-319-17440-2
5) Saaksvuori, Antti and Immpnen, Anselmi. " Product Lifecycle Management", Springer- Verlag, 2013. ISBN 978-3-540-26906-9
6) PDM : Product Data Management : Burden, Rodger, Resource Pub, 2013. ISBN: 978- 0970035226
7) Suggested Software Packages : Catia V5R19, Delmia V5R19, 3D via Composer, 3DXML player, Smart Team V5R19

Module No	Module Contents	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	**20MEE653.1**
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	**20MEE653.2 20MEE653.3**
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	**20MEE653.3 20MEE653.4**
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	**20MEE653.4**
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	**20MEE653.5 20MEE653.6**

Assessment Pattern

CIE (50 Marks – Theory)

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

SUPPLY CHAIN MANAGEMENT

Course Code	20MEE654
L: T: P:S	3:0:0:0
Exams Hours	03

Credits	03
CIE Marks	50
SEE Marks	50

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

20MEE654.1	Understand the functions of logistics and supply chain management
20MEE654.2	Apply the concepts and activities of the supply chain to practical applications in organizations
20MEE654.3	Identify the various technologies used in logistics and supply chain management
20MEE654.4	Evaluate various cases studies for effective supply chain management and its implementation
20MEE654.5	Analyze the various costs associated with inventory management
20MEE654.6	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
20MEE654.1	2										3			
20MEE654.2		3									3			1
20MEE654.3		3									3			
20MEE654.4		3									3			
20MEE654.5		3									3			
20MEE654.6		3									3			

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

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) A Text Book of Logistics and Supply chain management, Agarwal D.K. - 1st edition, Macmillan

Module No	Module Contents	Hrs	COs
1	**Introduction:** Basic concepts & philosophy of SCM, essential features, decision phases – process view, supply chain framework, key issues in SCM and benefits.	8	**20MEE654.1 20MEE654.2**
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.	9	**20MEE654.3**
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.	9	**20MEE654.4**
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.	9	**20MEE654.5**
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.	9	**20MEE654.5 20MEE654.6**

Assessment Pattern

CIE (50 Marks – Theory)

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

COMPUTATIONAL FLUID DYNAMICS

Course Code	20MEE655		Credits	03
L: T: P:S	3:0:0:0		CIE Marks	50
Exams Hours	03		SEE Marks	50

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

20MEE655.1	Understand in-depth introduction to the methods and analysis techniques used in computational solutions of fluid mechanics and heat transfer problems.
20MEE655.2	Demonstrate experience in the application of CFD analysis to real Engineering designs.
20MEE655.3	Apply the knowledge to Model problems and to study the interaction of physical processes and numerical techniques.
20MEE655.4	Analyze Contemporary methods for boundary layers, incompressible viscous flows, and inviscid compressible flows are studied.
20MEE655.5	Design problems using proper turbulence models
20MEE655.6	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
20MEE655.1	3	3	3	3										3
20MEE655.2	3	3	3	3										3
20MEE655.3	3	3	3	3										3
20MEE655.4	3	3	3	3										3
20MEE655.5		3	3	3										3
20MEE655.6			3	3										3

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

TEXT BOOKS:
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.

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

Module No	Module Contents	Hrs	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 Boundary conditions**.	9	20MEE655.1
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	20MEE655.2
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 of Finite 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	20MEE655.3
4	**Grid Generation:** Structured Grid Generation: Algebraic Methods, PDE mapping methods, use of grid control functions, Surface grid generation, 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 Meshenrichment method.	9	20MEE655.4 20MEE655.6
5	**Finite Volume Techniques:** Finite volume Discretisation-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 cambered aerfoil.	9	20MEE655.5 20MEE655.6

Assessment Pattern

CIE (50 Marks – Theory)

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

FUNDAMENTALS OF HEAT TRANSFER LAB

Course Code	20MEL61		Credits	01
L: T: P:S	0:0:1:0		CIE Marks	25
Exams Hours	03		SEE Marks	25

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

20MEL61.1	Apply the concept of steady state heat conduction in analytical and numerical method to determine the temperature distributions and heat flux in metal rod and composite wall.
20MEL61.2	Formulate the conduction equations for one dimensional heat transfer systems like Fins, Lumped systems and develop the solution for the temperature distributions within the body
20MEL61.3	Analyze the black body concept of radiation to determine the emissivity and Stefan boltzman constant
20MEL61.4	Analysis of 1D and 2D Thermal problems solving Conduction and Convection Boundary conditions
20MEL61.5	Analyze the free convection and forced convection heat transfer in a duct and vertical flat plate.
20MEL61.6	Determination of LMTD, effectiveness and heat transfer coefficient for heat exchanger and analyze the concept boiling and condensation.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEL61.1	3	3			1								3	
20MEL61.2	3	3											3	
20MEL61.3	3	3											3	
20MEL61.4	3			1									3	
20MEL61.5	3	3											3	
20MEL61.6	3	3											3	

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

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,
4) John Wiley and son's, 7th Ed, ISBN : 978-1-118-37924-0
5) Heat transfer-A basic approach, Ozisik, Tata McGraw Hill 2002.

Exp. No.	Contents of Experiment	Hrs	COs
1	Determination of Thermal Conductivity of a Metal Rod.	3	20MEL61.1 20MEL61.2
2	Determination of Overall Heat Transfer Coefficient of a Composite wall.	3	20MEL61.1 20MEL61.2
3	Thermal Analysis of Composite walls using FEM.	3	20MEL61.1 20MEL61.2
4	Experiment on Transient Heat Conduction.	3	20MEL61.2 20MEL61.5
5	Analysis of 1D and 2D Thermal problems solving Conduction and Convection Boundary conditions(min 4 problems)	3	20MEL61.2 20MEL61.5
6	Determination of Heat Transfer Coefficient in a free Convection on a vertical/horizontal tube.	3	20MEL61.4 20MEL61.5
7	Determination of Heat Transfer Coefficient in a Forced Convention Flow through a Pipe	3	20MEL61.4 20MEL61.5
8	Determination of Heat transfer co-efficient, efficiency & Effectiveness on a Metallic fin by Free and forced convection	3	20MEL61.4 20MEL61.5
9	Determination of Heat transfer co-efficient, efficiency & Effectiveness on a Metallic fin by forced convection	3	20MEL61.4 20MEL61.5
10	Determination of Emissivity of a Surface.	3	20MEL61.3 20MEL61.4
11	Determination of Stefan Boltzman Constant	3	20MEL61.3 20MEL61.4
	Determination of heat transfer coefficient in film and drop wise condensation.	3	20MEL61.5 20MEL61.6
	Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers	3	20MEL61.5 20MEL61.6

Assessment Pattern

CIE (25 Marks – Lab)

Bloom's Category	Experiments / Tests	Record	Viva
Marks	10	10	5
Remember			1
Understand			1
Apply		3	1
Analyze	5	3	1
Evaluate	5	4	1
Create			

SEE (25 Marks – Lab)

Bloom's Category	Test
Remember	5
Understand	5
Apply	5
Analyze	5
Evaluate	5
Create	

FINITE ELEMENT METHODS LAB

Course Code	20MEL62		Credits	01
L: T: P:S	0:0:1:0		CIE Marks	25
Exams Hours	03		SEE Marks	25

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

20MEL62.1	Synthesis the Inversions of mechanisms for different motion transfer scenarios.
20MEL62.2	Analyze the velocity and acceleration of mechanisms and machines in operating conditions.
20MEL62.3	Determine the causes and solutions for Unbalance in rotary components of different machines.
20MEL62.4	Apply the Principles of statics and dynamics in understanding the behavior of machines andmechanisms.
20MEL62.5	Illustrate the inertial parameters and variables which affect the performance of Governors.
20MEL62.6	Investigate the effects of Gyroscopic couple on different applications involving Prime movers.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEL62.1		3	3	3	3									3
20MEL62.2		3	3	3	3									3
20MEL62.3		3	3	3	3									3
20MEL62.4		3	3	3	3									3
20MEL62.5		3	3	3	3									3
20MEL62.6		3	3	3	3									3

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

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

Exp. No.	Contents of Experiment	Hrs	COs
1	Introduction to FEA package and stress analysis.	2	20MEL62.1 20MEL62.2
2	Bars of constant cross section.	2	20MEL62.2 20MEL62.4
3	Bars of tapered cross section and stepped bar.	2	20MEL62.2 20MEL62.4
4	Stress analysis of a rectangular plate with a hole	2	20MEL62.3 20MEL62.4
5	Problems with trusses.	2	20MEL62.4 20MEL62.5
6	Problems with trusses.	2	20MEL62.4 20MEL62.5
7	Beams: cantilever with various loading conditions.	2	20MEL62.4 20MEL62.5
8	Beams: simply supported beams with different loadi ng conditions.	2	20MEL62.4 20MEL62.5
9	Dynamic analysis: fixed-fixed beam for natural frequency determination	2	20MEL62.6
10	Dynamic analysis of a bar subjected to forcing function.	2	20MEL62.6
11	Dynamic analysis of a fixed-fixed bar subjected to forcing Function.	2	20MEL62.6

Assessment Pattern

CIE (25 Marks – Lab)

Bloom's Category	Experiments / Tests	Record	Viva
Marks	**10**	**10**	**5**
Remember			1
Understand			1
Apply		3	1
Analyze	5	3	1
Evaluate	5	4	1
Create			

SEE (25 Marks – Lab)

| Bloom's Category	Test
Remember	5
Understand	5
Apply	5
Analyze	5
Evaluate	5
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. here 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

Course Outcome

↓

Program Outcome

↓

Program Educational Objectives

↓

Department Mission

↓

Department Vision
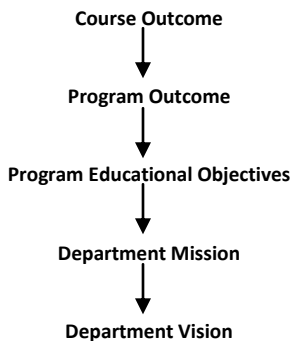
APPENDIX-B
The Graduate Attributes of NBA

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

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

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

Conduct investigations of complex problems: The problems that cannot be solved by straightforward application of knowledge, theories and techniques applicable to the engineering discipline that may not have a unique solution. For example, a design problem can be solved in many ways and lead to multiple possible solutions that require consideration of appropriate constraints/requirements not explicitly given in the problem statement (like: cost, power requirement, durability, product life, etc.) which need to be defined (modeled) within appropriate mathematical framework that often require use of modern computational concepts and tools.

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.

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.

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

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

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

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.

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.

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]**

Create — Produce new or original work
Design, assemble, construct, conjecture, develop, formulate, author, investigate

Evaluate — Justify a stand or decision
Appraise, argue, defend, judge, select, support, value, critique, weigh

Analyze — Draw connections among ideas
Differentiate, organize, relate, compare, contrast, distinguish, examine, experiment, question, test

Apply — Use information in new situations
Execute, implement, solve, use, demonstrate, interpret, operate, schedule, sketch

Understand — Explain ideas or concepts
Classify, describe, discuss, explain, identify, locate, recognize, report, select, translate

Remember — Recall facts and basic concepts
Define, duplicate, list, memorize, repeat, state