ANNAMALAI UNIVERSITY

Faculty of Engineering and Technology

B.E. MECHANICAL EnginEEring
(Full Time)

DEPARTMENT OF MECHANICAL ENGINEERING

Board of Studies

2019

VISION

The Mechanical Engineering Department endeavors to be recognized globally for outstanding education and research leading to well qualified engineers, who are innovative, entrepreneurial and successful in advanced fields of mechanical engineering to cater the ever changing industrial demands and social needs.

MISSION

The Mechanical Engineering program makes available a high quality, relevant engineering education. The Program dedicates itself to providing students with a set of skills, knowledge and attitudes that will permit its graduates to succeed and thrive as engineers and leaders. The Program strives to:

- **Prepare the graduates to pursue life-long learning, serve the profession and meet intellectual, ethical and career challenges.**
- **Extend a vital, state-of-the-art infrastructure to the students and faculty with opportunities to create, interpret, apply and disseminate knowledge.**
- **Develop the student community with wider knowledge in the emerging fields of Mechanical Engineering.**
- **Provide set of skills, knowledge and attitude that will permit the graduates to succeed and thrive as engineers and leaders.**
- **Create a conducive and supportive environment for all round growth of the students, faculty & staff**

PROGRAM EDUCATIONAL OBJECTIVES

1. Prepare the graduates with a solid foundation in Engineering, Science and Technology for a successful career in Mechanical Engineering.

2. Train the students to solve problems in Mechanical Engineering and related areas by engineering analysis, computation and experimentation, including understanding basic mathematical and scientific principles.

3. Inculcate students with professional and ethical attitude, effective communication skills, team work skills and multidisciplinary approach

4. Provide opportunity to the students to expand their horizon beyond mechanical engineering

5. Develop the students to adapt to the rapidly changing environment in the areas of mechanical engineering and scale new heights in their profession through lifelong learning

B.E. MECHANICAL ENGINEERING

PROGRAMME OUTCOMES

PO1: Engineering Knowledge: Graduates will be able to apply knowledge of mathematics, science and engineering for the solution of mechanical engineering problems.

PO2: Problem analysis: Graduates will be able to formulate and analyze complex mechanical engineering problems.

PO3: Design/development of solutions. Graduates will be able to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, and public health.

PO4: Conduct investigations of complex problems: Graduates will be able to design and conduct experiments, and to analyze and interpret data.

PO5: Modern tool usage: Graduates will be able to use the techniques, skills, and modern engineering tools necessary for mechanical engineering practice.

PO6: The engineer and society: Graduates will be able to include social, cultural, ethical issues with engineering solutions.

PO7: 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.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

PO9: Individual and team work: Graduates will be able to function effectively on multidisciplinary teams.

PO10: Communication: Graduates will be able to communicate effectively.

PO11: 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

PO12: Life-long learning: Graduates will be able to adopt technological changes and promote life-long learning.

Mapping PO with PEO					
POs	**PEO1**	**PEO2**	**PEO3**	**PEO4**	**PEO5**
PO1	✓	✓			✓
PO2	✓	✓			✓
PO3	✓	✓			✓
PO4		✓			
PO5		✓	✓		✓
PO6			✓	✓	
PO7	✓		✓	✓	✓
PO8	✓		✓	✓	
PO9	✓			✓	✓
PO10		✓	✓	✓	✓
PO11	✓	✓		✓	✓
PO12	✓	✓	✓	✓	✓

ANNAMALAI UNIVERSITY
FACULTY OF ENGINEERING AND TECHNOLOGY
B.E. (Four Year) Degree Programme (FULL–TIME)
Choice Based Credit System (CBCS)
Curriculum for First Year B.E

DEPARTMENT OF MECHANICAL ENGINEERING
COURSES OF STUDY AND SCHEME OF EXAMINATIONS (REGULATION -2019)

SEMESTER I

Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
ETBS101	**BS-I**	Physics	3	1	0	25	75	100	4
ETBS102	**BS-II**	Mathematics – I	3	1	0	25	75	100	4
ETES103	**ES-I**	Basic Electrical Engineering	3	1	0	25	75	100	4
ETBP104	**BSP-I**	Physics Laboratory	0	0	3	40	60	100	1.5
ETSP105	**ESP-I**	Electrical Engineering Laboratory	0	0	2	40	60	100	1
ETSP106	**ESP-II**	Engineering Workshop/ Manufacturing Practices	1	0	4	40	60	100	3
						Total Credits			**17.5**

SEMESTER II

Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
ETHS201	**HS-I**	English	2	0	0	25	75	100	2
ETBS202	**BS-III**	Chemistry	3	1	0	25	75	100	4
ETES203	**ES-II**	Programming for Problem Solving	3	0	0	25	75	100	3
ETBS204	**BS-IV**	Mathematics – II	3	1	0	25	75	100	4
ETHP205	**HSP-I**	Communication Skills and Language Laboratory	0	0	2	40	60	100	1
ETBP206	**BSP-II**	Chemistry Laboratory	0	0	3	40	60	100	1.5
ETSP207	**ESP-III**	Computer Programming Lab	0	0	4	40	60	100	2
ETSP208	**ESP-IV**	Engineering Graphics and Drafting	1	0	4	40	60	100	3
						Total Credits			**20.5**

Students must undergo Internship for 4 weeks during summer vacation which will be assessed in the forthcoming III Semester.

THIRD SEMESTER

Sl. No.	Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
1	ETBS301	**BS-V**	Engineering Mathematics III	3	1		25	75	100	4
2	ETES302	**BS-VI**	Environmental Studies	3			25	75	100	3
3	CEES303	**ES-II**	Engineering Mechanics	3			25	75	100	3
4	MEES304	**ES-III**	Basic Electronic Engineering	2			25	75	100	2
5	MEPC305	**PC-I**	Thermodynamics	3			25	75	100	3
6	MEPC306	**PC-II**	Solid mechanics	3			25	75	100	4
7	MESP307	**ESP-IV**	Electronics Lab			3	40	60	100	1.5
8	MECP308	**PCP-I**	Thermal Lab			3	40	60	100	1.5
9	MECP309	**PCP-II**	Machine Drawing			3				1.5
10	ETIT310	**IT-I**	Internship Inter/ Intra Institutional Activities*	***Four*** *weeks during the summer vacation at the end of* ***II Semester***				100	100	**4.0**
For the ***Lateral entry students total credit for III Semester is ***23.5*** as they are exempted from internship during summer vacation of II semester.*								**Total Credits**		**27.5**

FOURTH SEMESTER

Sl. No.	Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
1	EEBS401	**BS-VII**	Probability random process and Numerical methods	2	1		25	75	100	3
2	MEES402	**ES-IV**	Soft Skills Development	2			25	75	100	2
3	MEPC403	**PC-III**	Strength of Materials	3			25	75	100	3
4	MEPC404	**PC-IV**	Fluid Mechanics & Fluid Machines	3			25	75	100	3
5	MEPC405	**PC-V**	Manufacturing Processes	3			25	75	100	3
6	MEPC406	**PC-VI**	Design of Machine Elements	3			25	75	100	3
7	MECP407	**PCP-III**	Strength of Materials Lab			3	40	60	100	1.5
8	MECP408	**PCP-IV**	Hydraulics lab			3	40	60	100	1.5
9	MECP409	**PCP V**	Manufacturing Lab 1			3				1.5
							Total Credits			**21.5**
Students must undergo Internship for 4 weeks during summer vacation which will be assessed in the forthcoming V Semester.										

FIFTH SEMESTER

Sl. No.	Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
1	MEPC501	**PC-VII**	Materials engineering	3			25	75	100	3
2	MEPC502	**PC-VIII**	Instrumentation & control	3			25	75	100	3
3	MEPC503	**PC-IX**	Manufacturing Technology	3			25	75	100	3
4	MEPC504	**PC-X**	Kinematics and theory of machines	3			25	75	100	3
5	MEPE505	**PE-I**	Professional elective 1	3			25	75	100	3
6	MEPE506	**PE-II**	Professional elective 2	3			25	75	100	3
7	MECP507	**PCP-VI**	Manufacturing lab 2			3	40	60	100	1.5
8	MECP508	**PCP-VII**	Machine theory lab			3	40	60	100	1.5
9	MECP509	**PCP-VIII**	Instrumentation & Controls lab			3	40	60	100	1.5
10	ETIT510	**IT-II**	Industrial Training / Rural Internship / Innovation / Entrepreneurship	***Four*** *weeks during the summer vacation at the end of* ***IV Semester***				100	100	**4.0**
				Total Credits						**26.5**

SIXTH SEMESTER

Sl. No.	Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
1	MEPC601	**PC-XI**	Automation in Manufacturing	3	-	-	25	75	100	3
2	MEPC602	**PC-XII**	Applied Thermodynamics	3	-	-	25	75	100	3
3	MEPE603	**PE-III**	Professional elective3	3	-	-	25	75	100	3
4	MEPE604	**PE-IV**	Professional elective4	3	-	-	25	75	100	3
5	MEPE605	**PE-V**	Professional elective5	3	-	-	25	75	100	3
6	YYOE606	**OE-I**	Open elective I	3	-	-	25	75	100	3
7	MECP607	**PCP-IX**	Applied thermal lab	-	-	3	40	60	100	1.5
8	MECP608	**PCP-X**	Automation lab	-	-	3	40	60	100	1.5
				Total Credits						**21.0**
Students must undergo Internship for 4 weeks during summer vacation which will be assessed in the forthcoming VII Semester.										

SEVENTH SEMESTER

Sl. No.	Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
1	ETHS701	HS-IV	Engineering Ethics	2	**-**	**-**	**25**	**75**	**100**	**2**
2	MEPC702	PC-XIII	Heat Transfer	3	-	-	25	75	100	3
3	MEPE703	PE-VI	Professional elective 6	3	-	-	25	75	100	3
4	MEPE704	PE-VII	Professional elective 7	3	-	-	25	75	100	3
5	YYOE705	OE-II	Open Elective 2 Allied branch	3	-	-	25	75	100	3
6	MECP706	PCP-XI	Heat transfer lab	-		3	40	60	100	1.5
7	ETIT707	**IT-III**	Industrial Training / Rural Internship/ Innovation / Entrepreneurship	***Four*** *weeks during the summer vacation at the end of* ***VI Semester***				100	100	**4.0**
				Total Credits						**19.5**

EIGHTH SEMESTER

Sl. No.	Course Code	Category	Course	L	T	P	CA	FE	Total	Credits
1	MEOE801	OE-III	Open Elective 3 (From the same Department)	3	-	-	25	75	100	3
2	MEOE802	OE-IV	Open Elective 4 (From the same Department)	3	-	-	25	75	100	3
3	MEPV803	PV-I	Project Work & Viva voce	-	PR	S				
					10	2	40	60	100	6
				Total Credits						**12**

L	No. of Lecture Hours	**PR**	No. of Hours for Discussion on Project work
T	No. of Tutorial Hours	**S**	No. of Seminar Hours on Industrial Training / Project
P	No. of Practical Hours	**FE**	Final Examination Marks
CA	Continuous Assessment Marks		
Credits	Credit points allotted to that course	**Total**	Total Marks

PROFESSIONAL ELECTIVES

1. MEPE SCN Internal Combustion Engines
2. MEPE SCN Mechatronic Systems
3. MEPE SCN Microprocessors in Automation
4. MEPE SCN Composite Materials
5. MEPE SCN Computer Aided Design and Manufacturing
6. MEPE SCN Refrigeration and Air Conditioning
7. MEPE SCN Finite Element Analysis
8. MEPE SCN Power Plant Engineering
9. MEPE SCN Gas Dynamics and Jet Propulsion
10. MEPE SCN Process Planning and Cost Estimation
11. MEPE SCN Principles of Management
12. MEPE SCN Automobile Engineering
13. MEPE SCN Design of Transmission Systems
14. MEPE SCN Total Quality Management
15. MEPE SCN Energy Conservation and Management

OPEN ELECTIVES

1. MEOE SCN Automotive Engineering
2. MEOE SCN Automotive Safety
3. MEOE SCN Electric and hybrid vehicles
4. MEOE SCN Computational fluid dynamics
5. MEOE SCN Finite element methods
6. MEOE SCN Energy Engineering Technology and Management
7. MEOE SCN Renewable energy technology
8. MEOE SCN Industrial pollution prevention and control
9. MEOE SCN Power plant instrumentation
10. MEOE SCN Introduction to hydraulics and pneumatics
11. MEOE SCN Basic thermodynamics and heat transfer
12. MEOE SCN Energy auditing
13. MEOE SCN Energy conservation
14. MEOE SCN Solar energy utilization
15. MEOE SCN Waste heat recovery and co generation
16. MEOE SCN Maintenance & Safety Engineering
17. MEOE SCN Engine Pollution & Control

HONOURS ELECTIVES

1. MEHE SCN Computational Heat transfer
2. MEHE SCN Steam Engineering
3. MEHE SCN Advanced Engines and Emission Systems
4. MEHE SCN Energy Auditing
5. MEHE SCN Mechanical Vibration
6. MEHE SCN Robotics

MINOR ELECTIVES

1. MEMI SCN Basic Thermal Engineering
2. MEMI SCN Instrumentation and Control
3. MEMI SCN Elements of Heat transfer
4. MEMI SCN Elements of Machine Design
5. MEMI SCN Power Plant Technology
6. MEMI SCN Automobile Technology

THIRD SEMESTER

ETBS301	ENGINEERING MATHEMATICS III	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

- To learn, partial differential equations, Fourier series, Boundary value problems.
- To learn the transforms such as Sine, Cosine, Fourier transform and Z-transforms.
- To gain knowledge of the method to find the Solution of difference equations.

UNIT I

Formation of partial differential equations by eliminating arbitrary constants and arbitrary functions - Solution of standard type of first order partial differential equations - Lagrange's linear equation - Linear partial differential equations of second order with constant coefficients.

UNIT II

Dirichle's conditions - General Fourier series - Odd and Even functions - Half range sine series - Half range cosine series - Complex form of Fourier series – Parseval's identity.

UNIT III

Solutions of one dimensional wave equation – One dimensional heat equation (without derivation) – Fourier series solutions in Cartesian co-ordinates.

UNIT IV

Fourier integral theorem (without proof) – Fourier transform pair – Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem - Parseval's identity.

UNIT V

Z - transform – Elementary properties – Inverse Z – transform - Convolution theorem – Solution of difference equations using Z – transform.

TEXT BOOKS

1. Kandasamy P , Tilagavathy K and Gunavathy K, "Engineering Mathematics" ,6th edition., (Vol I & II) S.Chand& Co Ltd. 2006, New Delhi.
2. Ventakataraman M K, "Engineering Mathematics", The National Publishing Co., Chennai, 2003.

REFERENCES

1. Veerarajan T, "Engineering Mathematics", 3 rd edition, Tata McGraw Hill Pub., 2005.
2. Singaravelu A, "Engineering Mathematics", Meenakshi Publications, Chennai, 2004.
3. Nayaranan S, Manicavchagom Pillay T K and Ramanaiah G "Advanced Mathematics for Engineeirng students", Vol.2 & 3, S. Viswanathan Publishers Pvt. Ltd., 1998
4. Bali.N.P. and Manish Goyal, "A Textbook of Engineeirng Mathematics", 7th Edition, Laxmi Publications Pvt. Ltd., 2007

COURSE OUTCOMES

At the end of the course the students will be able to acquire knowledge on

1. Partial differential equations.
2. Fourier series.
3. Fourier transform.
4. Z-transforms and the methods of solving them.
5. Solving boundary value problems.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓						✓				
CO2	✓	✓	✓		✓			✓		✓	✓	
CO3	✓	✓		✓	✓			✓	✓			
CO4	✓	✓				✓	✓	✓				
CO5	✓	✓	✓	✓				✓				✓

ETES302	**ENVIRONMENTAL STUDIES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To study the nature and the facts about environment.
- To find and implement scientific, technological, economic and political solutions to environmental problems.
- To Study the dynamic processes and understand the features of the earth interior and surface.

Unit–I Introduction - Multidisciplinary nature of environmental studies - Definition, scope and importance - Need for public awareness. Natural resources - Forest resources: use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.- Role of an individual in conservation of natural resources.- Equitable use of resources for sustainable lifestyles.

Unit–II Concept of an ecosystem - Structure and function of an ecosystem - Producers, consumers and decomposers - Energy flow in the ecosystem - Ecological succession - Food chains, food webs and ecological - pyramids - Introduction, types, characteristic features, structure and function of the following ecosystem - Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit–III Introduction – Definition: genetic, species and ecosystem diversity - Bio geographical classification of India - Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values - Biodiversity at global, National and local levels - India as a mega-diversity nation - Hot-spots of biodiversity - Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts - Endangered and endemic species of India - Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Unit–IV Definition - Cause, effects and control measures of Air pollution - Water pollution - Soil pollution - Marine pollution- Noise pollution - Thermal pollution - Nuclear hazards- Solid waste Management: Causes, effects and control measures of urban and industrial wastes - Role of an individual in prevention of pollution - Disaster management: floods, earthquake, cyclone and landslides.

Sustainable development - Urban problems related to energy - Water conservation, rain water harvesting, and watershed management - Resettlement and rehabilitation of people; its problems and concerns. - Environmental ethics: Issues and possible solutions - Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.

Wasteland reclamation - Consumerism and waste products - Environment Protection Act - Air (Prevention and Control of Pollution) Act - Water (Prevention and control of Pollution) Act - Wildlife Protection Act - Forest Conservation Act - Issues involved in enforcement of environmental legislation.

Unit–V Population growth, variation among nations - Population explosion – Family Welfare Programme - Environment and human health - Human Rights - Value Education - HIV/AIDS - Women and Child Welfare - Role of Information Technology in Environment and human health - Case Studies.

Field Work

Visit to a local area to document environmental assets-river / forest / grassland / hill / mountain - Visit to a local polluted site-Urban/Rural/ Industrial/ Agricultural - Study of common plants, insects, birds - Study of simple ecosystems-pond, river, hill slopes, etc. **(Field work Equal to 5 lecture hours)**

TEXT BOOKS

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R)

REFERENCES

1. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
2. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
3. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai, 1196p
4. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
5. Down to Earth, Centre for Science and Environment (R)

(M) Magazine (R) Reference (TB) Textbook

COURSE OUTCOMES

Upon completion of this course, the students will be able to

1. Gain public awareness of environment at infant stage.
2. Gain basic knowledge on the significance of environmental studies
3. Develop their standard of living
4. Understand the effects of environmental disasters.
5. Understand Human rights

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓					✓						
CO2				✓								
CO3					✓		✓					✓
CO4	✓		✓		✓							✓
CO5	✓								✓			✓

ETES303	**ENGINEERING MECHANICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To introduce the fundamentals of forces and their effects with their governing laws.
- To understand the definitions of particle, body forces and their equilibrium conditions.
- To understand and predict the forces and its related motions

UNIT-I Introduction to Engineering Mechanics-Force Systems-Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminancy

UNIT-II Basic Structural Analysis covering, Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines Centroid and Centre of Gravity covering, Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook.

UNIT-III Friction covering, Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack.

Virtual Work and Energy Method- Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium.

UNIT-IV Review of particle dynamics- Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2nd law (rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy.Impulse-momentum (linear, angular); Impact (Direct and oblique).

UNIT-V Introduction to Kinetics of Rigid Bodies covering, Basic terms, general principles in dynamics; Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D'Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation

Mechanical Vibrations covering, Basic terminology, free and forced vibrations, resonance and its effects; Degree of freedom; Derivation for frequency and amplitude of free vibrations without damping and single degree of freedom system, simple problems, types of pendulum, use of simple, compound and torsion pendulums;

Tutorials from the above modules covering, To find the various forces and angles including resultants in various parts of wall crane, roof truss, pipes, etc.; To verify the line of polygon on various forces; To find coefficient of friction between various materials on inclined plan; Free body diagrams various systems including block-pulley; To verify the principle of moment in the disc apparatus; Helical block; To draw a load efficiency curve for a screw jack

TEXT BOOKS

1. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall
2. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill

REFERENCES

1. R. C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
2. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford University Press
3. Shanes and Rao (2006), Engineering Mechanics, Pearson Education,
4. Hibler and Gupta (2010),Engineering Mechanics (Statics, Dynamics) by Pearson Education
5. Reddy Vijaykumar K. and K. Suresh Kumar(2010), Singer's Engineering Mechanics
6. Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications
7. Khurmi R.S. (2010), Engineering Mechanics, S. Chand & Co.
8. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications

COURSE OUTCOMES

At the end of this course, students will demonstrate the ability to

1. Understand the concepts of co-ordinate systems.
2. Analyze the three-dimensional motion.
3. Understand the concepts of rigid bodies.
4. Analyze the free-body diagrams of different arrangements.
5. Analyze torsional motion and bending moment.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓		✓								✓	
CO2	✓	✓	✓	✓								
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

MEES304	BASIC ELECTRONIC ENGINEERING	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES

- To provide an overview of electronic device components to Mechanical engineering students.
- To learn the fundamentals of Digital Electronics.

Unit-I: Semiconductor Devices and Applications: Introduction to P-N junction Diode and V-I characteristics, Half wave and Full-wave rectifiers, capacitor filter. Zener diode and its characteristics, Zener diode as voltage regulator. Regulated power supply IC based on 78XX and 79XX series, Introduction to BJT, its input-output and transfer characteristics, BJT as a single stage CE amplifier, frequency response and bandwidth.

Unit-II: Operational amplifier and its applications: Introduction to operational amplifiers, Op-amp input modes and parameters, Op-amp in open loop configuration, op-amp with negative feedback, study of practical op-amp IC 741, inverting and non-inverting amplifier applications: summing and difference amplifier, unity gain buffer, comparator, integrator and differentiator.

Unit-III: Timing Circuits and Oscillators: RC-timing circuits, IC 555 and its applications as astable and mono-stable multi-vibrators, positive feedback, Barkhausen's criteria for oscillation, R-C phase shift and Wein bridge oscillator.

Unit-IV: Digital Electronics Fundamentals :Difference between analog and digital signals, Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification using Kmap, Logic ICs, half and full adder/subtractor, multiplexers, de-multiplexers, flip-flops, shift registers, counters, Block diagram of microprocessor/microcontroller and their applications.

Unit-V: Electronic Communication Systems: The elements of communication system, IEEE frequency spectrum, Transmission media: wired and wireless, need of modulation, AM and FM modulation schemes, Mobile communication systems: cellular concept and block diagram of GSM system.

TEXT BOOKS

1. Floyd ," Electronic Devices" Pearson Education 9th edition, 2012.
2. R.P. Jain , "Modern Digital Electronics", Tata Mc Graw Hill, 3rd Edition, 2007.

REFERENCES

1. Frenzel, "Communication Electronics: Principles and Applications", Tata Mc Graw Hill, 3rd Edition, 2001

COURSE OUTCOMES

At the end of this course students will demonstrate the ability to

1. Understand the principles of semiconductor devices and their applications.
2. Design an application using Operational amplifier.
3. Understand the working of timing circuits and oscillators.
4. Understand logic gates, flip flop as a building block of digital systems.
5. Learn the basics of Electronic communication system.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓				✓					✓		✓
CO2	✓				✓							✓
CO3	✓			✓								✓
CO4	✓	✓			✓							✓
CO5	✓			✓								✓

MEPC305	**THERMODYNAMICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To learn about work and heat interactions, and balance of energy between system and its surroundings
- To learn about application of I law to various energy conversion devices
- To evaluate the changes in properties of substances in various processes
- To understand the difference between high grade and low grade energies and II law limitations on energy conversion

Unit-I: Fundamentals - System & Control volume; Property, State & Process; Exact & Inexact differentials; Work-Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work. Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers- Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy E ; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy.

Unit-II: First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume.

Unit-III: Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale. Clausius inequality; Definition of entropy S ; Demonstration that entropy S is a property; Evaluation of S for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Determination of s from steam tables- Principle of increase of entropy; Illustration of processes in Ts coordinates;

Unit-IV: Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Compressibility charts- Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables and R134a tables; Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart

Unit-V: Thermodynamic cycles - Basic Rankine cycle; Basic Brayton cycle; Basic vapor compression cycle and comparison with Carnot cycle. Definition of Isentropic efficiency for compressors, turbines and nozzles-Irreversibility and Availability, Availability function for systems and Control volumes undergoing different processes, Lost work. Second law analysis for a control volume. Exergy balance equation and Exergy analysis.

TEXT BOOKS

1. Engineering Thermodynamics, P.K. Nag, Tata McGraw Hill
2. Thermodynamics –An Engineering Approach –Yunus A Cengel & Michael A Boles

REFERENCES

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of a Thermodynamics, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall of India
3. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.
4. Basic and Applied Thermodynamics, P.K. Nag, Tata McGraw Hill.

COURSE OUTCOMES

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

1. Apply energy balance to systems and control volumes, in situations involving heat and work interactions
2. Evaluate changes in thermodynamic properties of substances
3. Evaluate the performance of energy conversion devices
4. Differentiate between high grade and low grade energies.
5. Learn various thermodynamic cycles

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓		✓									
CO2	✓	✓	✓									
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

MEPC306	**SOLID MECHANICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- The objective is to present the mathematical and physical principles in understanding the linear continuum behavior of solids.
- To learn the basics of stress and strain.

Unit-I: Introduction to Cartesian tensors, Strains: Concept of strain, derivation of small strain tensor and compatibility, Stress: Derivation of Cauchy relations and equilibrium and symmetry equations, principal stresses and directions

Unit-II: Constitutive equations: Generalized Hooke's law, Linear elasticity, Material symmetry;

Unit-III: Boundary Value Problems: concepts of uniqueness and superposition.
Plane stress and plane strain problems, introduction to governing equations in cylindrical and spherical coordinates, axisymmetric problems.

Unit-IV: Application to thick cylinders, rotating discs, torsion of non-circular cross-sections, stress concentration problems, thermo-elasticity, 2-d contact problems.

Unit-V: Solutions using potentials. Energy methods. Introduction to plasticity.

TEXT BOOKS

1. G. T. Mase, R. E. Smelser and G. E. Mase, Continuum Mechanics for Engineers, Third Edition,CRC Press, 2004.
2. Y. C. Fung, Foundations of Solid Mechanics, Prentice Hall International, 1965.

REFERENCES

1. Lawrence. E. Malvern, Introduction to Mechanics of a Continuous Medium, Prentice Hall International, 1969.
2. Strength of Materials, D.S. Bedi, Khanna Publishing House
3. Strength of Materials, R Subramanian, Oxford University Press
4. Strength of Materials, RK Bansal, Laxmi Publications
5. Mechanics of Materials, Punmia, Jain and Jain, Laxmi Publications

COURSE OUTCOMES

Upon completion of this course, students will be able to

1. Learn the basics of stress and strain
2. Learn the significance of Hooks law.
3. Understand the deformation behavior of solids under different types of loading and obtain mathematical solutions for simple geometries.
4. Understand the stress behavior on cylindrical surfaces
5. Learn the basics of plasticity.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓	✓	✓								
CO2	✓	✓		✓								
CO3	✓	✓	✓	✓								
CO4	✓	✓	✓	✓								
CO5	✓											

MESP307	ELECTRONICS LAB	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- To understand the operation of basic electronic devices.
- To understand the basic functions of operational amplifier.
- To illustrate the application of operational amplifier.
- To understand the basic code conversion and Karnaugh Map reduction

List of Experiments

1. Characteristics of Junction diode, Characteristics of Zener diode and Zener diode as a voltage regulator.
2. Half wave and full wave rectifiers with and without capacitor filter.
3. Mathematical operations using OP-AMP
4. Zero crossing detector using OP-AMP
5. Schmitt trigger using OP-AMP
6. R.C Phase Shift Oscillator using OP-AMP
7. Design of a stable and Bistable multivibrator.
8. Verification of basic gates and logic circuit using universal building blocks.
9. Karnaugh Map reduction
10. Multiplexer and Demultiplexer
11. Design of Modulo UP and DOWN Counters
12. Design of Half adder and full adder circuits

COURSE OUTCOMES

1. Learn the application and characteristics of basic electronic devices.
2. Gain knowledge to troubleshoot various electronic circuits.
3. Understand the functional characteristics of linear IC as a rectifiers, converters and amplifiers.
4. Acquire the operating theory of combinational and sequential circuits.
5. Explore the use of digital logic in integrated circuit applications.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓	✓		✓				✓			✓
CO2	✓	✓	✓		✓				✓			
CO3	✓	✓	✓		✓				✓			
CO4	✓	✓	✓		✓				✓			
CO5	✓	✓	✓		✓	✓			✓			✓

MECP308	THERMAL LAB	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- To inculcate the knowledge about the working of I.C engines and different types of dynamometers.
- To study the valve timing and port timing of an IC engine
- To study and determine the properties of fuel like kinematic viscocity, calorific value etc.

List of Experiments

1. Study and valve timing on four stroke diesel engine.
2. Study and port-timing on two stroke petrol engine.
3. Dismantling and assembling of four stroke single cylinder diesel engine
4. Study of various parts of multi-cylinder diesel/petrol engine.
5. Study of Carburetor
6. Study of fuel injection pump
7. Study of cooling system
8. Study of lubrication system
9. Study of air compressor
10. Determination of calorific value of liquid fuel
11. Determination of flash and fire point of liquid fuel
12. Determination of cloud and pour point fuel
13. Determination of kinematic viscosity of fuel

COURSE OUTCOMES

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

1. Understand the various types of engines
2. Learn the working principles of dynamometers.
3. Know the dismantling and assembling procedure of a four stroke CI engines.
4. Determine kinematic viscosity and the influence of temperature on viscosity.
5. Determine the properties of fuels

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓			✓	✓				✓			✓
CO2	✓			✓	✓				✓			✓
CO3	✓			✓	✓				✓			✓
CO4	✓			✓	✓				✓			✓
CO5	✓			✓	✓				✓			✓

MECP309	MACHINE DRAWING	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- Students have an ability to apply knowledge of modeling, science & engineering.
- Student can modeled this drawing even in CAD/CAM software by applying the basic knowledge of machine drawing.

- Students will able to demonstrate an ability to design and conduct experiments, analyze and interpret data, assembly and disassembly drawings knowledge will be provided.

Free Hand Sketches

Fasteners: Different form of rivet heads – Single, double riveted lap and butt joints - Foundation bolts - Locking arrangements for nuts - lock nut, split pin, locking plate and spring washer - Stud Set screws – Different forms of machine screws - pan, countersunk, slotted and philip headed screws - Keys - sunk taper key, gib headed taper key, feather key, woodruff key, saddle key.

Orthographic and Assembly Drawings

To draw orthographic views from the given isometric views of simple objects. Detailed assembly drawing and additional views from the given drawing.

(a) Shaft coupling - Protected type and Pin type flexible coupling
(b) Bearings and Supports - Bushed bearing, Foot step bearing and Plummer Block
(c) Eccentric
(d) Steam engine stuffing box
(e) Screw jack.

TEXT BOOKS

1. Gopalakrishna, K.R., Machine Drawing, Subhas stores, Bangalore.
2. Bhatt, N.D., Machine Drawing, Charotar Publishing House.

REFERENCES

1. Parkinson, A.C. (Sinha), A First Year Engineering Drawing, Wheeler Publishers, New Delhi.
2. Parkinson, A.C., Intermediate Engineering Drawing.
3. Narayana, K.L., Kanniah, P. & Venkata Reddy, K., A Text Book on Production Drawing, Premier Publishing House, Hydrabad.
4. Narayana, K.L., Kanniah, P. & Venkata Reddy, K., Machine Drawing, New Age International (P) Limited, Publishers.
5. Lakshmi Narayanan, V. & Mathur, M.L., A Text Book of Machine Drawing, Jain Brothers Publishers.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Improve their imagination skills
2. Improve their drawing skills
3. Understand and apply the knowledge of machine drawing as a system of communication in which ideas are expressed clearly and all information fully conveyed.
4. Understand the design of a system, component or process to meet desired needs within realistic constraints such as manufacturability, economic, environmental, safety & sustainability etc.., to represent a part drawing and assembly drawings.
5. Recognize the need and an ability to engage in self education and life-long learning.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓		✓						✓			✓
CO2	✓		✓						✓			✓
CO3	✓		✓						✓			✓
CO4	✓		✓						✓			✓
CO5	✓		✓						✓			✓

FOURTH SEMESTER

EEBS401	PROBABILITY RANDOM PROCESS AND NUMERICAL METHODS	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES

- Be exposed to probability, random processes, and statistical methods designed to contribute to the process of making scientific judgments in the face of uncertainty and variation.
- To develop the skills of the students in numerical mathematics - using method of finite difference interpolation, finding numerical solution of algebraic and transcendental equations, and finding numerical solution of ordinary and partial differential equations.

Unit–I : Probability and Random Variables

Definition – Types of random variables - probability distribution function - probability density function – expectation and moments – moment generating functions –joint probability distribution - marginal probability distribution function – joint probability density function – marginal probability density function – conditional probability density function.

Unit–II : Random Processes

Classification of random processes – methods of description of a random process – special classes of random processes – Average values of random process - stationarity –Autocorrelation function and its properties - cross correlation function and its properties.

Unit–III : Test of Significance

Hypothesis, testing – Large sampling tests – small sampling test based on t, F and chi-square distributions – interval estimates of mean, standard deviation and proportion.

Unit–IV : Interpolation, Numerical Differentiation and Integration

Interpolation: Gregory Newton forward and backward interpolation formula; Stirling's central difference formula; Lagrange's interpolation formula for unequal interval. Numerical differentiation: Using Newton's forward and backward interpolation formula. Numerical integration: Trapezoidal rule, Simpson's one-third and three-eight rule.

Unit–V : Solution of Algebraic, Transcendental and ordinary Differential Equations

Solution of algebraic and transcendental equations: Bolzano's bisection method, Regula-falsi method, Newton–Raphson method.

Solution of simultaneous algebraic equation: Gauss elimination method, Crout's method, Gauss – Seidel iteration method.

Solution of ordinary differential equations: Taylor series method, Runge–Kutta fourth order method, Milne's - Predictor corrector method.

TEXT BOOKS

1. Kandasamy, P., Thilagavathy, K., and Gunavathy, K., Probability and Random Processes, S.Chand & Co. Ltd.
2. Veerarajan, T., Probability Theory and Random Process, Tata McGraw Hill Co., Ltd. New Delhi 2005.

REFERENCES

1. Venkataraman, M.K., Numerical Method in Science and Engineering, National Publishing Co., Chennai - 2003.
2. Lipschutz, S. and Schiller. J., Schaums' Outlines – Introduction to Probability and Statistics, McGraw Hill, New Delhi, 1998.
3. Kandasamy, P., Thilagavathy, K., and Gunavathy, K., Numerical Methods, S. Chand & Co. Ltd., New Delhi. 2004.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Acquire skills in handling situations involving random variables
2. Able to solve problems on random processes
3. Solve problems using numerical methods.
4. Solve problems on integration
5. Solve problems on differential equations

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓	✓	✓								
CO2	✓	✓	✓	✓								
CO3	✓	✓	✓	✓								
CO4	✓	✓	✓	✓								
CO5	✓	✓	✓	✓								

MEES402	**SOFT SKILLS DEVELOPMENT**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**

COURSE OBJECTIVES

- Today's world is all about relationship, communication and presenting oneself, one's ideas and the company in the most positive and impactful way.
- This course intends to enable students to achieve excellence in both personal and professional life.

Unit-I Know Thyself/ Understanding Self Introduction to Soft skills-Self discovery-Developing positive attitude-Improving perceptions-Forming values

Unit-II Interpersonal Skills/ Understanding Others Developing interpersonal relationship-Team building-group dynamics-Net working-Improved work relationship

Unit-III Communication Skills / Communication with others Art of listening-Art of reading-Art of speaking-Art of writing-Art of writing e-mails-e mail etiquette

Unit-IV Corporate Skills / Working with Others Developing body language-Practising etiquette and mannerism-Time management-Stress management

Unit-V Selling Self / Job Hunting Writing resume/cv-interview skills-Group discussion- Mock interview-Mock GD – Goal setting - Career planning

TEXT BOOKS

1. Meena.K and V. Ayothi (2013) A Book on Development of Soft Skills (Soft Skills : A Road Map to Success), P.R. Publishers & Distributors, No, B-20 & 21, V.M.M. Complex, Chatiram Bus Stand, Tiruchirappalli- 620 002.
2. Alex K. (2012) Soft Skills – Know Yourself & Know the World, S.Chand & Company LTD, Ram Nagar, New Delhi- 110 055.

REFERENCES

1. Developing the leader within you John c Maxwel
2. Good to Great by Jim Collins
3. The seven habits of highly effective people Stephen Covey
4. Emotional Intelligence Daniel Goleman
5. Principle centred leadership Stephen Covey

COURSE OUTCOMES

After completing this course, the students should be able to

1. Understand the human values
2. Develop Interpersonal relationship
3. Improve their communication skills
4. Handle time and stress effectively
5. Plan their carrier

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1						✓		✓				✓
CO2						✓		✓				✓
CO3						✓				✓		
CO4				✓							✓	
CO5						✓			✓			

MEPC403	**STRENGTH OF MATERIALS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres for various types of simple loads
- To calculate the elastic deformation occurring in various simple geometries for different types of loading

Unit-I: Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr's circle.

Unit-II: Beams and types transverse loading on beams- shear force and bend moment diagrams- Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads.

Unit-III: Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems.

Unit-IV: Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs.

Unit-V: Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure.

TEXT BOOKS

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
2. R. Subramanian, Strength of Materials, Oxford University Press, 2007.

REFERENCES

1. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGrawHill Publishing Co. Ltd., New Delhi 2005.
2. Strength of Materials, D.S. Bedi, Khanna Publishing, Delhi
3. Strength of Materials, R.K. Rajput, Laxmi Publications
4. Strength of Materials, R. Subramanian, Oxford Publications

COURSE OUTCOMES

After completing this course, the students should be able to

1. Recognize various types loads applied on machine components of simple geometry
2. Understand the nature of internal stresses developed within the components
3. Evaluate the strains and deformation that will result due to the elastic stresses developed within the materials for simple types of loading
4. Learn the basics of torsional stresses
5. Understand the effects of axial stresses

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO6**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓	✓	✓								
CO2	✓	✓	✓	✓								
CO3	✓	✓	✓	✓								
CO4	✓	✓	✓	✓								
CO5	✓	✓	✓	✓								

MEPC404	FLUID MECHANICS & FLUID MACHINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To learn about the application of mass and momentum conservation laws for fluid flows
- To understand the importance of dimensional analysis
- To obtain the velocity and pressure variations in various types of simple flows
- To analyze the flow in water pumps and turbines.

Unit-I: Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, Control volume- application of continuity equation and momentum equation, Incompressible flow, Bernoulli's equation and its applications.

Unit-II: Exact flow solutions in channels and ducts, Couette and Poisuielle flow, laminar flow through circular conduits and circular annuli- concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, friction factor, Moody's diagram.

Unit-III: Need for dimensional analysis–methods of dimension analysis–Similitude–types of similitude Dimensionless parameters–application of dimensionless parameters–Model analysis.

Unit-IV: Euler's equation – theory of Rotodynamic machines – various efficiencies – velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves – Cavitation in pumps- Reciprocating pump–working principle.

Unit-V: Classification of water turbines, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles – draft tube- Specific speed, Unit-quantities, performance curves for turbines – governing of turbines.

TEXT BOOKS

1. Fluid Mechanics, Sadhu Singh, Khanna Publishing House, NewDelhi
2. Hydraulics and Fluid Mechanics, Modi P.N., Seth S.M Standard Book House, NewDelhi.

REFERENCES

1. Bansal R.K., A Text Book of Fluid Mechanics and Hydraulic Machinery,9th ed., Laxmi Publication, New Delhi, 2005.

COURSE OUTCOMES

Upon completion of this course, students will be able to

1. Learn the basics of fluid mechanics
2. Analyze simple flow situations mathematically
3. Understand the significance of dimensionless parameters
4. Gain knowledge about the functions of fluid machines
5. Able to evaluate the performance of pumps and turbines.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓						✓					✓
CO2	✓	✓	✓	✓								
CO3	✓	✓			✓							
CO4	✓			✓	✓							✓
CO5	✓		✓						✓		✓	✓

MEPC405	**MANUFACTURING PROCESSES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To learn the various manufacturing process.
- To motivate and challenge students to understand and develop an appreciation of the processes in correlation with material properties which change the shape, size and form of the raw materials into the desirable product by conventional or unconventional manufacturing methods

Unit-I: Conventional Manufacturing processes:
Casting and moulding: Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses. Introduction to bulk and sheet metal forming, plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk forming(forging, rolling, extrusion, drawing) and sheet forming (shearing, deep drawing, bending) principles of powder metallurgy, plastic injection moulding.

Unit-II: Metal cutting:
Single and multi-point cutting; Orthogonal cutting, various force components: Chip formation, Tool wear and tool life, Surface finish and integrity, Machinability, Cutting tool materials, Cutting fluids, Coating; Turning, Drilling, Milling and finishing processes, Introduction to CNC machining.

Unit-III: Additive manufacturing:
Rapid prototyping and rapid tooling. Joining/fastening processes: Physics of welding, brazing and soldering; design considerations in welding, Solid and liquid state joining processes; Adhesive bonding.

Unit-IV: Unconventional Machining Processes:
Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, principles and process parameters Electrical Discharge Machining, principle and processes parameters, MRR, surface finish, tool wear, dielectric, power and control circuits, wire EDM.

Unit-V: Electro-chemical machining (ECM), etchant &maskant, process parameters, MRR and surface finish. Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining.

TEXT BOOKS

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)- Pearson India, 2014
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems

REFERENCES

1. Degarmo, Black &Kohser, Materials and Processes in Manufacturing

COURSE OUTCOMES

Upon completion of this course, students will be able to

1. Understand the different conventional manufacturing processes
2. Learn the basics of metal cutting
3. Learn the basics of additive manufacturing
4. Introduce unconventional manufacturing methods
5. Understand advanced machining processes for a lifelong learning.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓				✓	✓			✓			✓
CO2	✓				✓	✓			✓			✓
CO3	✓				✓	✓			✓			✓
CO4	✓				✓	✓			✓			✓
CO5	✓				✓	✓			✓			✓

MEPC406	**DESIGN OF MACHINE ELEMENTS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To familiarize the various steps involved in the Design Process.
- To understand the principles involved in evaluating the shape and dimensions of Component to satisfy functional and strength requirements.
- To learn to use standard practices and standard data To learn to use catalogues and standard machine components.

Unit–I Introduction: Types of Design factors. Factor of safety, Theories of failure - Curved beam, Crane hook and C frames. Design for fatigue strength: S-N diagram - Endurance limit modifying factors - Stress concentration - Fluctuation stress –Soderberg & Good Man equations.

Unit–II Shafts - Material and design stresses - Calculation of equivalent bending moment and twisting moment - Design of shafts subjected to combined bending moment and twisting moment.

Unit–III Theory of columns: Design of push rod, piston rod and I.C. Engine connecting rods sections. Wire ropes - Stresses - selection Design procedure–leaf springs - construction equalized stresses in leaves - material and design. Open and closed coiled helical springs stress - Wahl's factor.

Unit–IV Power screws - Thread forms Design consideration and materials - wear and shear - design procedure. Coupling - Types - Design and selection of coupling - Flange coupling, Bushed pin type, flexible coupling design and selection.

Unit–V Design of Joints: Riveted Joints: Introduction - Types of riveted joints - failures of a riveted joint - strength and efficiency - Design of boiler joints. Welded joints: Introduction - Strength of transverse and parallel fillet welded joints - Axially loaded unsymmetrical welded sections - Eccentrically loaded welded joints.

TEXT BOOKS

1. A Textbook of Machine Design, RS Khurmi, S.Chand Publications
2. Pandya and Sha, Machine Design, Charotar Pub. House, Anand, India.

REFERENCES

1. Machine Design, Sadhu Singh, Khanna Publishing House, Delhi
2. Machine Design Data Book, Sadhu Singh, Khanna Publishing House
3. Design Data Book, Mahadevan, CBS Publishers & Distributors
4. Introduction to Machine Design, V.B. Bhandhari, McGraw Hill
5. Richard Budynnas and J.E. Shigley's, Mechanical Engineering Design, McGraw Hill Book Company, 8th ed., 2008.
6. Prabhu, T.J., Fundamentals of Machine Design, 4th ed. 2000, Scitech Pub.
7. Sundararajamoorthy, T.V. & N. Shanmugam, Machine Design, Anuradha Agencies.2000.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Appreciate the functions of various machine elements and assemblies
2. Design various machine components according to the requirement as per the prescribed standards
3. Apply the knowledge of materials and their properties
4. Use a standard design data book.
5. Understand the significance of designing joints

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO6**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓		✓									✓
CO2	✓		✓									✓
CO3	✓		✓									✓
CO4	✓		✓									✓
CO5	✓		✓									✓

MECP407	STRENGTH OF MATERIALS LAB	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- To impart practical training on simple machines like screw jack, worm wheel, etc.
- To understand the theoretical and practical aspects of elasticity and plasticity of the materials through a variety of experiments.
- To determine the mechanical advantage and efficiency of some of the simple machines like screw jack, worm wheel, differential wheel and axle.
- To study the behavior of the materials by conducting tension, compression and shear, hardness impact, deflection and ductility tests.

List of Experiments

1. Simple machine-compound wheel and axle.
2. Screw Jack
3. Worm wheel
4. Handle Winch
5. Deflection Test on Steel Pipe
6. Tension Test Steel Rod
7. Izod Impact Test
8. Shear Test on steel rod
9. Brinell Hardness Test
10. Rockwell Hardness Test
11. Test on Helical Springs

COURSE OUTCOMES

Upon completion of the course, the students will be able to

1. Analyze and design structural members subjected to tension, compression, torsion, bending and combined stresses
2. Learn the fundamental concepts of stress, strain and elastic behavior of materials.
3. Utilize appropriate materials in design considering engineering properties, sustainability, cost and weight.
4. Perform engineering work in accordance with ethical and economic constraints related to the design of structures and machine parts.
5. Work as a team to gain practical knowledge, helpful for a lifelong learning.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓	✓	✓					✓			
CO2	✓	✓	✓	✓					✓			
CO3	✓	✓	✓	✓					✓			
CO4	✓		✓					✓	✓			✓
CO5	✓								✓		✓	

MECP408	HYDRAULICS LAB	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- To understand the properties of fluids and fluid statics, methods for determination of co-efficient of discharged are to be explained and computed practically.
- To study of the characteristic features of pumps and turbines using experiments in envisaged.
- To understand the significance and role of such utilities in their further course of study.

List of Experiments

1. Determination of Co-efficient of discharge of Mouth Piece.
2. Determination of Co-efficient of discharge of Venturimeter.
3. Determination of Co-efficient of Head loss due to Sudden Change in Section.
4. Determination of Co-efficient of Head loss due to Friction in Pipe.
5. Determination of Co-efficient of discharge of Rectangular Notch.
6. Study of Performance characteristics of Elmo Pump (Centrifugal Pump).
7. Study of Performance characteristics of Sump Pump (Centrifugal Pump).
8. Study of Performance characteristics of Submersible Pump (Centrifugal Pump).
9. Study of Performance characteristics of Gould's Pump (Reciprocating Pump).
10. Study of Performance characteristics of Pelton Turbine (Constant Speed method).
11. Study of Performance characteristics of Francis Turbine (Constant Head method).
12. Determination of Metacentric Height of a floating vessel (Demo Only).

COURSE OUTCOMES

Upon completion of the course, the students will be able to

1. Determine the properties of fluids, pressure and their measurements.
2. Measure flow in pipes and determine frictional losses.
3. Compute forces on immersed plane and curved plates applying continuity equation and energy equation in solving problems on flow through conduits.
4. Determine the characteristics of pumps
5. Determine the characteristics of turbines.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO6**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓			✓					✓			✓
CO2	✓			✓					✓			✓
CO3	✓			✓					✓			✓
CO4	✓			✓					✓			✓
CO5	✓			✓					✓			✓

MECP409	MANUFACTURING LAB 1	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- To impart practical training to the students on various welding processes
- To develop procedural and manual skills in machining and also to provide training in making greensand moulds

List of Experiments

Foundry shop

1. Face Plate (Solid Pattern)
2. Hexagonal Nut (Self Core Pattern)
3. Ball Handle (Split Pattern)
4. Pipe Flange (Split Pattern)
5. Lathe Saddle (Loose Piece Pattern)

Welding shop

1. Butt Joint
2. Lap Joint
3. Corner Joint
4. Arc Welding Power Sources with Effect of Heat input on bed geometry
5. Temperature Measurement of Arc Welding Process
6. Non-destructive testing of Welding

Machine shop

1. Plain Turning
2. Step Turning
3. Taper Turning
4. Thread Cutting

COURSE OUTCOMES

Upon the completion of this course, the students will be able to

1. Handle metal working machine (Lathe) for making simple operations
2. Prepare green sand moulds of given patterns
3. Prepare different types of weld joints.
4. Understand non destructive testing
5. Work as a team for a lifelong learning

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO6**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓			✓					✓			✓
CO2	✓			✓					✓			✓
CO3	✓			✓					✓			✓
CO4	✓			✓					✓			✓
CO5	✓			✓					✓			✓

FIFTH SEMESTER

MEPC501	MATERIALS ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- Understanding of the correlation between the internal structure of materials, their mechanical properties and various methods to quantify their mechanical integrity and failure criteria.
- To provide a detailed interpretation of equilibrium phase diagrams
- Learning about different phases and heat treatment methods to tailor the properties of Fe-C alloys.

Unit-I Crystal Structure: Unit-cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress. Mechanical Property measurement: Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength.

Unit-II Static failure theories: Ductile and brittle failure mechanisms, Tresca, Von-mises, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb; Fracture mechanics: Introduction to Stress intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Fracture with fatigue, Introduction to non-destructive testing (NDT)

Unit-III Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstrctural aspects of ledeburite, austenite, ferrite and cementite, cast iron.

Unit-IV Heat treatment of Steel: Annealing, tempering, normalising and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening

Unit-V Alloying of steel, properties of stainless steel and tool steels, maraging steels- cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and cupro-nickel; Aluminium and Al-Cu – Mg alloys- Nickel based superalloys and Titanium alloys. Introduction to Corrosion and coatings

TEXT BOOKS

1. W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition, Wiley India.
2. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.

REFERENCES

1. V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 1999.
2. U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011.
3. Engineering Materials Properties and Selection, Budinski and Budinski, PHI
4. Material Science & Engineering, R. Balasubhramanium, Wiley India

COURSE OUTCOMES

Upon the completion of this course, the students will be able to

1. Identify crystal structures for various materials
2. Understand the defects in materials
3. Understand how to tailor material properties of ferrous and non-ferrous alloys
4. Learn the effects of heat treatment in steels
5. How to quantify mechanical integrity and failure in materials

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓										
CO2	✓	✓										
CO3	✓	✓	✓	✓								
CO4	✓	✓										✓
CO5	✓											✓

MEPC502	**INSTRUMENTATION & CONTROL**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To provide a basic knowledge about measurement systems and their components
- To learn about various sensors used for measurement of mechanical quantities
- To learn about system stability and control
- To integrate the measurement systems with the process for process monitoring and control

Unit–I Generalised measurement system - Basic standards of measurement - Errors - Classification. Measurements of displacement, force and torque. Dynamometers: Hydraulic, Absorption and Eddy current.

Unit–II Measurement of strain - Bonded and unbounded strain gauges - Requirements of materials. Mechanical - Electrical - Opto mechanical strain gauges. Measurement of temperature - electrical and non-electrical methods - Bimetallic and pressure thermometer, thermocouples - requirements - Resistance thermometers - Pyrometry - Calibration methods.

Unit–III Measurements of Pressure and flow - Measurements of high pressure and low pressure - Measurements of flow by obstruction meters - Velocity probes - Hot wire anemometer - Calibration of pressure gauges and flow meters - Time constant of pressure gauges.

Unit–IV Elementary ideas of automatic control - Open and closed systems, on-off, proportional, and floating modes, reset and rate actions. Basic combined modes for pneumatic, hydraulic and electrical systems.

Unit–V Transfer function - Stability - Routh's criterion - Analysis of second order systems – System response to step – step, pulse - ramp inputs. Introduction to computerized measurement and control systems (Description only)

TEXT BOOKS

1. Hollman, J.P., Experimental Methods for Engineers, Tata McGraw Hill.
2. Benjamin Kuo, Automotive Control Engineering, EEE Publications.

REFERENCES

1. D.S. Kumar, 'Mechanical Measurement & Control', Metropolitan Book Company.
2. Beckwith, T.C & Buck, N.L., Mechanical Measurements, Addison Wesley.
3. Nagarth and Gopal, Control Engineering, Wiley Eastern Ltd.
4. Control System by Nagoor Kani, RBA Publications.
5. Erenest O. Doebeling, 'Measurement Systems', McGraw Hill.
6. Instrumentation and control systems by W. Bolton, 2nd edition, Newnes, 2000
7. Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard, Mechanical Measurements 6th Edition, Pearson Education India, 2007
8. Gregory K. McMillan, Process/Industrial Instruments and Controls Handbook, Fifth Edition, McGraw-Hill: New York, 1999.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

1. Learn basic measurement systems
2. Design and maintain measuring equipments for the measurement of temperature and flow
3. Work in quality control and quality assurances divisions in industries
4. Design a sensors and transducers used for stress analysis.
5. Understand the significance of transfer functions.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓				✓							✓
CO2	✓		✓		✓							
CO3	✓									✓	✓	
CO4	✓	✓	✓									✓
CO5	✓				✓						✓	✓

MEPC503	MANUFACTURING TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To provide knowledge on machines and related tools for manufacturing various components.
- To understand the relationship between process and system in manufacturing domain.
- To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.

Unit-I Tooling for conventional and non-conventional machining processes: Mould and die design, Press tools, Cutting tools; Holding tools: Jigs and fixtures, principles, applications and design; press tools – configuration, design of die and punch; principles of forging die design.

Unit-II Metrology: Dimensions, forms and surface measurements, Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; Metrology in tool wear and part quality including surface integrity, alignment and testing methods; tolerance analysis in manufacturing and assembly. Process metrology for emerging machining processes such as microscale machining, Inspection and workpiece quality GD&T Introduction.

Unit-III Assembly practices: Manufacturing and assembly, process planning, selective assembly, Material handling and devices.

Unit-IV Linear programming, objective function and constraints, graphical method, Simplex and duplex algorithms, transportation assignment, Traveling Salesman problem; Network models: shortest route, minimal spanning tree, maximum flow model- Project networks: CPM and PERT, critical path scheduling;

Unit-V Production planning& control: Forecasting models, aggregate production planning, materials requirement planning. Inventory Models: Economic Order Quantity, quantity discount models, stochastic inventory models, practical inventory control models, JIT. Simple queuing theory models.

TEXT BOOKS:

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)-PearsonIndia, 2014.
2. Taha H. A., Operations Research, 6th Edition, Prentice Hall of India, 2003.

REFERENCES

1. Shenoy G.V. and Shrivastava U.K., Operations Research for Management, Wiley Eastern, 1994.
2. Manufacturing Technology, Vol. 1, 2, 3, PN Rao, TMH
3. Manufacturing Technology, RK Rajput, Laxmi Publications
4. Production and Operations Management, S.N.Chary, TMH

COURSE OUTCOMES

Upon completion of this course, students will be able to

1. Understand the tooling needed for manufacturing.
2. Learn the various precise measurements
3. Understand the various material handling devices.
4. Apply optimization methods in manufacturing.
5. Learn the significance of forecasting in manufacturing.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓			✓	✓							
CO2	✓				✓							✓
CO3	✓		✓								✓	✓
CO4	✓	✓	✓		✓						✓	
CO5	✓	✓	✓			✓						

MEPC504	**KINEMATICS AND THEORY OF MACHINES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the kinematics and rigid- body dynamics of kinematically driven machine
- components
- To understand the motion of linked mechanisms in terms of the displacement, velocity and acceleration at any point in a rigid link
- To be able to design some linkage mechanisms and cam systems to generate specified output motion

Unit-I Classification of mechanisms-Basic kinematic concepts and definitions-Degree of freedom, mobility- Grashof's law, Kinematic inversions of four bar chain and slider crank chains-Limit positions-Mechanical advantage-Transmission angle-Description of some common mechanisms-Quick return mechanism, straight line generators-Universal Joint-Rocker mechanisms

Unit-II Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure equations kinematic analysis of simple mechanisms- slider crank mechanism dynamics-Coincident points-Coriolis component of acceleration- introduction to linkage synthesis- three position graphical synthesis for motion and path generation

Unit-III Classification of cams and followers-Terminology and definitions-Displacement diagrams- Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers Surface contacts- sliding and rolling friction- friction drives- bearings and lubrication- friction clutches- belt and rope drives- friction in brakes

Unit-IV Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics. Governors – Watt, Porter, Hartnell and Proell

Unit-V Elementary insights of vibrations – Free , forced and damped (Theory Only) Balancing of rotating masses – single rotating mass by single mass in same and different planes (Simple problems only) Balancing of reciprocating masses – Primary and secondary forces – swaying couples and hammer blow (Theory Only)

TEXT BOOKS

1. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2005.
2. Cleghorn W.L. , Mechanisms of Machines, Oxford University Press, 2005.

REFERENCES

1. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw Hill, 2009.
2. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, Affiliated East-West Pvt. Ltd, New Delhi, 1988.

COURSE OUTCOMES

Upon completion of the course, students can ale to

1. Design various types of linkage mechanisms
2. Determine specific motion and analyze them for optimal functioning
3. Learn the significance of cam and followers
4. Learn the basics of governers
5. Understand the need for balancing

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓		✓		✓							✓
CO2	✓	✓	✓									
CO3	✓			✓								✓
CO4	✓				✓							✓
CO5	✓			✓						✓		✓

MECP507	**MANUFACTURING LAB - II**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES

- To provide hands on experience in handling precise metrology instruments and their calibration.
- To provide hands on experience in special machines

List of Experiments

Machine Shop

1. Keyway machining using a shaper
2. Angular machining using a shaper
3. Convex profile machining on a slotter

Special Machine Shop

1. Plain milling
2. Spur gear milling

Metrology Lab

1. Inspection of screw - thread
   (A) Checking the straightness of straight edge
   (B) Measurement of radius (internal and external)
2. Calibration of micrometer

Metallurgy Lab

1. Effect of section size on hardness
2. End quenching (or) Jominy hardenability test

COURSE OUTCOMES

Upon the completion of this course, the students would be able to

1. Understand the usage of precision instruments and the handling methods.
2. Learn the basic operation of various traditional and non-traditional manufacturing processes.
3. Justify the most appropriate manufacturing process and material for a given product.
4. Select/Suggest process for the production of gears.
5. Work as a team to gain knowledge for a lifelong learning.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓	✓		✓	✓			✓			✓
CO2	✓		✓						✓			✓
CO3	✓		✓						✓			✓
CO4	✓	✓							✓			✓
CO5	✓								✓	✓	✓	✓

MECP508	**MACHINE THEORY LAB**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES

- To supplement the principles learnt in kinematics and Dynamics of Machinery.
- To make the students understand the working principle of various types of governors, balancing systems, Cam analyzer, Torsional vibration of single rotor system, whirling speed concept, action of forces in gyroscope.

List of Experiments

1. Experimental verification of natural frequency in undamped vibration of single rotor system.
2. Determine the characteristic curves of watt/ Hartnell governors.
3. Determination of mass moment of inertia of connecting rod and fly wheel.
4. Studies on cam analyser.
5. Study of gyroscopic couple.
6. Whirling of speed – determination of critical speed.
7. Study and experiments on static and dynamic balancing of rotating masses.

COURSE OUTCOMES

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

1. Determine the mass moment of inertia of connecting rod and flywheel either experimentally of theoretically or both.
2. Understand the working principle of governors.
3. Calculate the stiffness of springs.
4. Analyze the different types of motion in cams.
5. Ability to analyze particle dynamics

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓		✓						✓			✓
CO2	✓		✓						✓			✓
CO3	✓		✓						✓			✓
CO4	✓		✓						✓			✓
CO5	✓		✓						✓			✓

MECP509	**INSTRUMENTATION & CONTROLS LAB**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES

- To learn the temperature measuring techniques
- To make the students understand the working principle of various measuring devices.
- To understand the concept of proportional control action, integral control action and derivative control

List of Experiments

1. Determination of coefficient of discharge of Orificemeter
2. Determination of coefficient of discharge of Venturimeter
3. Determination of Reynolds number by Reynolds apparatus
4. Experiment on DC motor position control system
5. Experiments on DC Servo motor controller
6. Experiments on pressure process station by On/Off method
7. Experiments on temperature trainer by On/Off and PID method
8. Measurement of displacement using LVDT
9. Measurement of strain using strain gauge.
10. Measurement of temperature using resistance temperature detector
11. Temperature measurement by bimetallic thermometer

COURSE OUTCOMES

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

1. Classify various temperature measuring devices
2. Determine the coefficient of discharge of various flow measuring devices.
3. Understand the concept of proportional control action, integral control action and derivative control action in a control system.
4. Measure the procedure for measuring strain using strain gauge.
5. Work as a team to gain knowledge for a lifelong learning

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓			✓	✓				✓			✓
CO2	✓			✓	✓				✓			✓
CO3	✓			✓	✓				✓			✓
CO4	✓			✓	✓				✓			✓
CO5	✓			✓	✓				✓			✓

SIXTH SEMESTER

MEPC601	AUTOMATION IN MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To understand the importance of automation in the of field machine tool based manufacturing
- To get the knowledge of various elements of manufacturing automation – CAD/CAM,
- sensors, pneumatics, hydraulics and CNC
- To understand the basics of product design and the role of manufacturing automation

Unit-I Introduction: Why automation, Current trends, CAD, CAM, CIM; Rigid automation: Part handling, Machine tools.

Unit-II Flexible automation: Computer control of Machine Tools and Machining Centers, NC and NC part programming, CNC-Adaptive Control, Automated Material handling. Assembly, Flexible fixturing.

Unit-III Computer Aided Design: Fundamentals of CAD - Hardware in CAD-Computer Graphics Software and Data Base, Geometric modeling for downstream applications and analysis methods;

Unit-IV Computer Aided Manufacturing: CNC technology, PLC, Micro-controllers, CNC-Adaptive Control Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies

Unit-V Introduction to Modeling and Simulation: Product design, process route modeling, Optimization techniques, Case studies & industrial applications.

TEXT BOOKS

1. Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing, prentice Hall
2. SeropeKalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology, 7th edition,Pearson

REFERENCES

1. Yoram Koren, Computer control of manufacturing system, 1st edition
2. Ibrahim Zeid , CAD/CAM : Theory & Practice, 2nd edition.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

1. Understand the basics of CAD/CAM
2. Able to classify NC and CNC
3. Learn the basics of CAD
4. Learn the advanced topics in manufacturing
5. Understand the importance of modeling and simulation

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓				✓	✓		✓				✓
CO2	✓	✓										
CO3	✓				✓							✓
CO4	✓					✓						✓
CO5	✓				✓	✓						✓

MEPC602	**APPLIED THERMODYNAMICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To learn about of I law for reacting systems and heating value of fuels
- To learn about gas and vapor cycles and their first law and second law efficiencies
- To understand about the properties of dry and wet air and the principles of psychrometry
- To learn about gas dynamics of air flow and steam through nozzles

Unit-I Introduction to solid, liquid and gaseous fuels–Stoichiometry, exhaust gas analysis- First law analysis of combustion reactions- Heat calculations using enthalpy tables- Adiabatic flame temperature- Chemical equilibrium and equilibrium composition calculations using free energy.

Unit-II Vapor power cycles Rankine cycle with superheat, reheat and regeneration, exergy analysis. Supercritical and ultra super-critical Rankine cycle- Gas power cycles, Air standard Otto, Diesel and Dual cycles-Air standard Brayton cycle, effect of reheat, regeneration and intercooling.

Unit-III Properties of dry and wet air, use of pschyrometric chart, processes involving heating/cooling and humidification/dehumidification, dew point. Combined gas and vapor power cycles- Vapor compression refrigeration cycles, refrigerants and their properties.

Unit-IV Basics of compressible flow. Stagnation properties, Isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows- normal shocks- use of ideal gas tables for isentropic flow and normal shock flow- Flow of steam and refrigerant through nozzle, super saturation compressible flow in diffusers, efficiency of nozzle and diffuser.

Unit-V Reciprocating compressors, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors. Analysis of steam turbines, velocity and pressure compounding of steam turbines.

TEXT BOOKS

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of
2. Thermodynamics, John Wiley and Sons.

REFERENCES

1. Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall of India
2. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.
3. Nag, P.K, 1995, Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd

COURSE OUTCOMES

After completing this course, the students will to

1. Learn various types of fuels
2. Understand various practical power cycles and heat pump cycles.
3. Learn the basics of compressible flow
4. Analyze energy conversion in various thermal devices such as combustors, air coolers, nozzles, diffusers, steam turbines and reciprocating compressors
5. Understand the phenomena occurring in high speed compressible flows.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓				✓							✓
CO2	✓		✓									
CO3	✓	✓										✓
CO4	✓	✓									✓	
CO5	✓	✓				✓						

MECP607	**APPLIED THERMAL LAB**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES

- To evaluate the performance and emission characteristics of an single cylinder diesel engine
- To conduct performance test on double stage reciprocating air compressor
- To conduct the heat balance test on single and double cylinder diesel engine.
- To understand the usage of different refrigeration tools.

List of Experiments

1. Load Test on Four Stroke Diesel Engine / petrol engine
2. Study and performance test on Air Compressor
3. Heat Balance Test on Four Stroke Diesel Engine
4. Speed test on multi cylinder Four Stroke Diesel Engine
5. Performance test on Refrigeration trainer
6. Trial on Ice Plant
7. Performance test on window air conditioner
8. Performance test on central A/C plant
9. Performance test on heat pump trainer

COURSE OUTCOMES

Upon completion of this practical class, the students will be able to:

1. Learn about the different heat losses in the engine viz., cooling water, exhaust gas and un-accountable losses.
2. To learn about the performance parameter of Diesel and Petrol engine.
3. To learn about the air compressor performance parameters.
4. Understand the basic analysis of any refrigeration system
5. Work as a team to gain knowledge for a lifelong learning.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓			✓	✓				✓			✓
CO2	✓			✓	✓				✓			✓
CO3	✓			✓	✓				✓			✓
CO4	✓			✓	✓				✓			✓
CO5	✓			✓	✓				✓			✓

MECP608	**AUTOMATION LAB**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES

- To understand the strength of OOPS using c++
- To impart programming skills in C++ programming.
- To provide hands-on experience in developing basic mechanical models and assembly drawing using AUTO CAD.
- To introduce the basics of MAT LAB.

List of Experiment

Search, generate, manipulate data using MS office/ Open Office
Presentation and Visualization – graphs, charts, 2D, 3D
Preliminary Auto CAD 2 D drawing exercise
Auto CAD machine drawing
Knuckle Joint
Bushed bearing
C++, Programming,
Otto cycle efficiency
Compressor dimensions
Simple MATLAB Exercises

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Attempt the basics in MS office
2. Write and compile programmes in C++
3. Develop assembly drawings with different views using auto cad
4. Exchange file formats between AutoCAD & other analysis packages
5. Solve simple mathematical models using MATLAB.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓		✓	✓	✓							✓
CO2	✓		✓	✓	✓							✓
CO3	✓		✓	✓	✓							✓
CO4	✓		✓	✓	✓							✓
CO5	✓		✓	✓	✓							✓

SEVENTH SEMESTER

ETHS701	ENGINEERING ETHICS	L	T	P
		2	0	0

COURSE OBJECTIVES

- To understand the moral and ethical dimensions in engineering.
- To take balanced decisions.

Unit-I Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Professions and Professionalism – Professional Ideals and Virtues – Uses of Ethical Theories.

Unit-II Engineering as Experimentation – Engineers as responsible Experimenters – Research Ethics - Codes of Ethics – Industrial Standards - A Balanced Outlook on Law – The Challenger Case Study.

Unit-III Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis – Reducing Risk – The Government Regulator's Approach to Risk - Chernobyl Case Studies and Bhopal.

Unit-IV Collegiality and Loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

Unit-V Multinational Corporations – Business Ethics - Environmental Ethics – Computer Ethics - Role in Technological Development – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Honesty – Moral Leadership – Sample Code of Conduct

TEXT BOOKS

1. Govindarajan M, Natarajan S and Senthilkumar, V S, "Professional Ethics And Human Values", PHI Learning, New Delhi, 2013.
2. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill, New York, 2005.

REFERENCES

1. Charles E Harris, Michael S Pritchard and Michael J Rabins, "Engineering Ethics – Concepts and Cases", Thompson Learning, 2000.
2. Charles D Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, 1999. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, 2003.
3. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, 2001.
4. David Ermann and Michele S Shauf, "Computers, Ethics and Society", Oxford University Press, (2003).

COURSE OUTCOMES

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

1. Understand the relationship between the engineer and the society.
2. Learn the importance of codes in engineering practice.
3. Acquire knowledge on the legal, moral and ethical aspects in engineering.
4. Understand the various rights of engineers
5. Understand the importance of honesty

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓							✓		✓		✓
CO2	✓							✓		✓		✓
CO3	✓							✓		✓		✓
CO4	✓							✓		✓		✓
CO5	✓							✓		✓		✓

MEPC702	**HEAT TRANSFER**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- The aim of the course is to build a solid foundation in heat transfer exposing students to the three basic modes namely conduction, convection and radiation.
- Rigorous treatment of governing equations and solution procedures for the three modes will be provided, along with solution of practical problems using empirical correlations.
- The course will also briefly cover boiling and condensation heat transfer, and the analysis and design of heat exchangers.

Unit-I: Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, Composite Medium, critical insulation thickness. Extended surfaces

Unit-II: Lumped system approximation and Biot number, Two dimensional conduction solutions for both steady and unsteady heat transfer-approximate solution to unsteady conduction heat transfer by the use of Heissler charts.

Unit-III: Heat convection, basic equations, boundary layers- Forced convection, external and internal flows-Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection- Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow-Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.

Unit-IV: Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method. Radiation Shields

Unit-V: Types of heat exchangers, Analysis and design of heat exchangers using both LMTD and ε-NTU methods. Boiling and Condensation heat transfer, Pool boiling curve. Introduction mass transfer, Similarity between heat and mass transfer.

TEXT BOOKS

1. Yunus A Cengel, Heat Transfer : A Practical Approach, McGraw Hill, 2002
2. J.P.Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.

REFERENCES

1. F.P. Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley, Sixth Edition, 2007.

2. Massoud Kaviany, Principles of Heat Transfer, John Wiley, 2002
3. A. Bejan, Heat Transfer John Wiley, 1993

COURSE OUTCOMES

After completing the course, the students will be able to

1. Formulate and analyze a heat transfer problem involving any of the three modes of heat transfer
2. Obtain exact solutions for the temperature variation using analytical methods
3. Design devices such as heat exchangers and also estimate the insulation needed
4. Learn the basics of radiation shields
5. Learn the basics of mass transfer.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓	✓	✓								
CO2	✓	✓	✓	✓								
CO3	✓	✓	✓	✓								
CO4	✓					✓					✓	
CO5	✓			✓								✓

MECP706	**HEAT TRANSFER LAB**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES

- To make the students understand the modes of heat transfer and to conduct the trails on various experiments to analyze the heat transfer parameters.
- To understand the behavior of a system at different operating conditions
- The students will learn the basics of solar energy, how to determine solar intensity, and how to estimate daily and annual solar energy potential at each location
- To evaluate the performance of steam boiler, turbine and condenser.

List of Experiments

1. Experiment on (parallel flow and counter flow) heat exchanger
2. Determination of Stefan-Boltzmann constant
3. Determination of critical heat flux
4. Experiment on composite wall apparatus.
5. Natural convection from vertical cylinder
6. Performance test on Solar air heater
7. Performance test on water heater
8. Performance test on Solar Still
9. Study and performance test on steam boilers
10. Study and performance test on Steam turbines
11. Study and performance test on Reader vertical steam engine.
12. Study and performance test on steam condenser.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Calculate the temperature distribution and heat conduction in the metal rod.
2. Evaluate the radiation heat transfer between surfaces.
3. Analyze the performance of heat exchanger.
4. Working of Solar Thermal plants: Flat Plate, Vacuum Tubes, Parabolic Trough and Concentric Mirrors.
5. Experimentally determine the performance of a steam boiler, turbine and condenser.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓			✓					✓			✓
CO2	✓			✓					✓			✓
CO3	✓			✓					✓			✓
CO4	✓			✓					✓			✓
CO5	✓			✓					✓			✓

MEST707	**SEMINAR/INDUSTRIAL TRAINING**	**L**	**TR**	**S**	**C**
			1	**2**	**2**

COURSE OBJECTIVES

- To expose students to the 'real' working environment and get acquainted with the organization structure, business operations and administrative functions.
- To have hands-on experience in the students' related field so that they can relate and reinforce what has been taught at the university.
- To promote cooperation and to develop synergetic collaboration between industry and the university in promoting a knowledgeable society.
- To set the stage for future recruitment by potential employers.

The student has to present a seminar on the chosen topic. However, the student can select a topic duly approved by the Seminar Coordinator and the Head of the Department concerned. The student who has presented the seminar has to submit a report and appear for viva-voce examination at the end of the semester conducted by faculty members nominated by head of the department.

For Industrial training, the student has to undergo training in a reputed industry for 15 days and has to submit a report on completion of the training. The report will be evaluated by a team of faculty members nominated by the head of the department.

COURSE OUTCOME

Upon completion of the Training, students will have the

1. Ability to work in a team
2. Ability to take initiatives.
3. Ability to effectively communicate solution to problems (oral, visual, written).
4. Ability to manage a project within a given time frame.
5. Ability to apply prior acquired knowledge in problem solving.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓					✓	✓		✓	✓		✓
CO2	✓					✓	✓		✓	✓		✓
CO3	✓					✓	✓		✓	✓		✓
CO4	✓					✓	✓		✓	✓		✓
CO5	✓					✓	✓		✓	✓		✓

EIGHTH SEMESTER

MEPV803	**PROJECT WORK & VIVA VOCE**	**L**	**PR**	**S**	**C**
			8	**4**	**10**

COURSE OBJECTIVES

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.

This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Take up any challenging practical problems and find solution by formulating proper methodology.
2. Students will acquire the ability to make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
3. Students will acquire collaborative skills through working in a team to achieve common goals.
4. Students will be able to learn on their own, reflect on their learning and take appropriate actions to improve it.
5. Students will acquire the skills to communicate effectively and to present ideas clearly and coherently to specific audience in both the written and oral forms.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓	✓	✓			✓		✓			✓
CO2	✓	✓	✓	✓			✓		✓			✓
CO3	✓	✓	✓	✓			✓		✓			✓
CO4	✓	✓	✓	✓			✓		✓			✓
CO5	✓	✓	✓	✓			✓		✓			✓

PROFESSIONAL ELECTIVE COURSES

MEPESCN	INTERNAL COMBUSTION ENGINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To familiarize with the terminology associated with IC engines.
- To understand the basics of IC engines.
- To understand combustion, and various parameters and variables affecting it in various types of IC engines.
- To learn about various systems used in IC engines and the type of IC engine required for various applications

UNIT-I - Advanced Engines

Advanced IC engine concept – gasoline direct injection (GDI) engine – homogeneous charge, stratified charge – spray, wall and air guided - ignition technology – plasma ignition – Lean burn concept – dual fuel engine - high pressure compression ignition engine - Homogeneous Charge Compression Ignition (HCCI) engine - hybrid electric vehicles **–** add on devices - variable valve timing (VVT) – VTEC - downsizing and turbo charging and their types.

UNIT-II – Ideal, Fuel – Air and Actual Cycles

Review of ideal cycles – fuel-air cycles – factors and assumptions - variable specific heats – effect on internal energy, enthalpy, entropy, expansion and heat transfer – effect on air standard efficiencies - effect of variation of specific heats – effect of common engine variables – actual cycles – factors affecting losses of actual cycle – comparison of ideal, fuel-air and actual cycles

UNIT-III - SI and CI Engine Combustion

SI engine combustion - combustion phenomenon – normal and abnormal combustion - pre ignition and detonation – effects and factors affecting knocking – factor influencing combustion chamber design – types of combustion chambers – CI engine combustion - combustion phenomenon – delay period – diesel knock – criteria for combustion chamber design – types of combustion chambers – cold start of CI engine

UNIT-IV - Fuel Supply Systems

Fuel supply system in SI engine – air fuel mixture formation – carburettors – mixture requirement at operating conditions – types of carburettors – design and operating principles – electronically controlled carburettors – gasoline injection systems – single point fuel injection – multi point fuel injection(MPFI) – gasoline direct injection(GDI) – fuel supply system in CI engine – fuel metering requirements – mechanical injection – common rail injection – fuel supply computations in SI and CI engine

UNIT-V – Auxiliries And Testing Of Ic Engine

Ignition system of SI engine – requirements - battery ignition system – magneto ignition system – electronic ignition system – lubrication system – engine friction – types of lubrication - wet sump, dry sump and mist lubrication – engine cooling – necessity of engine cooling – types of cooling – air cooling – liquid cooling – testing of IC engine – performance parameters – performance of SI and CI engine – emission formation in SI and CI engine - strategies for emission control – in-cylinder and after burn control

TEXT BOOKS

1. Obert E. F, “Internal Combustion Engines and Air Pollution”, Harper and Row Publication Inc. NY, 1973.

2. Heisler H, “Advanced Engine Technology”, Edward Arnold, 1995.

REFERENCES

1. Heywood J. B, “Internal Combustion Engine Fundamentals”, McGraw Hill Book Co. NY, 1989
2. Heldt P. M, “High Speed Combustion Engines”, Oxford & IBH publishing Co. India, 1985.
3. Stockel M W, Stockel T S and Johanson C, “Auto Fundamentals”, The Goodheart, Wilcox Co. Inc., Illinois, 1996.
4. Bosch “Automotive Handbook”, Fifth Edition, SEA Society of Automotive Engineers,400 Common wealth Drive, Warrendale, USA, 2000
5. Rajput R.K. “Internal Combustion Engines” Lakshmi Publications (P) Ltd., New Delhi, Second Edition reprint 2008.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Learn the working of latest engines
2. Understand the various working cycles
3. Understand the combustion phenomenon
4. Study the fuel supply system in a engine
5. Analyze the performance of a engine

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓				✓		✓					✓
CO2	✓				✓		✓					✓
CO3	✓				✓		✓					✓
CO4	✓				✓		✓					✓
CO5	✓				✓		✓					✓

MEPESCN	**MECHATRONIC SYSTEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To construct various system models and to determine their stability.
- To understand the functions and applications of sensors and transducers.
- To learn the structure of microprocessor and their applications in mechanical devices.

UNIT-I Introduction to Mechatronics - Open and Closed Loop System. Mathematical System Models and Transfer Function – Mechanical – Electrical - Thermal - Fluid Systems.

UNIT-II Construction and Reduction Techniques - Block Diagram - Signal Flow Graph. Stability Analysis – Routh Criterion - Frequency Response – Polar Plot - Bode Plot - Nichols Plot.

UNIT-III Sensors and Transducers: Static and Dynamic Characteristics of Sensor, Potentiometers - LVDT - Capacitance Sensors - Strain Gauges - Eddy Current Sensor - Hall Effect Sensor - Temperature Sensors - Light Sensors – Micro sensors. Signal Conditioning – Operational Amplifiers - Protection – Filtering - ADC and DAC.

UNIT-IV Actuation Systems – Construction - Working Principle - Characteristics - Stepper Motor and Servo Motor - Hydraulic and Pneumatic Systems - Micro actuators. Smart materials - Shape

Memory Alloy - Piezoelectric - Magnetostrictive Actuators. Introduction - Pin Configuration - Architecture of 8085 Microprocessor - Addressing Modes - Instruction Set, Timing Diagram of 8085.

UNIT-V Introduction - Architecture of PLC - Input / Output Processing - Programming with Timers, Counters and Internal Relays. Stages of Mechatronics Design Process - Comparison of Traditional and Mechatronics Design Concepts with Examples - Case Studies of Mechatronics Systems - Pick and Place Robot - Engine Management System – Automatic Car Park Barrier.

TEXT BOOKS

1. Bolton - Mechatronics - Electronic Control Systems in Mechanical and Electrical Engineering, Addison Wesley Longman Ltd., 2003.
2. Nagoor Kani. A – Control Systems, RBA Publications, Chennai, 2000.

REFERENCES BOOKS

1. Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Penram International Publishing Private Limited, 6th Edition, 2015.
2. Anthony Esposito, “Fluid Power with Applications”, Pearson Education Inc.,2003
3. Majumdar S.R., “Pneumatic Systems – Principles and maintenance”, Tata McGraw-Hill, 2001.
4. Devdas Shetty, Richard A. Kolk, “Mechatronics System Design”, Thomson Learning Publishing Company, Vikas Publishing House, 2001.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

1. Design a Mechatronics Systems
2. Handle Microprocessor, PLC and other Electrical and Electronics Circuits.
3. Gain knowledge related to Electronic circuits
4. Learn the functions of actuators
5. Learn the applications of mechatronic systems

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓	✓	✓								✓
CO2	✓	✓			✓	✓						✓
CO3	✓				✓	✓						✓
CO4	✓				✓							✓
CO5	✓		✓	✓							✓	✓

MEPESCN	**MICROPROCESSORS IN AUTOMATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To introduce the basic concepts of Digital circuits, Microprocessor system and digital controller
- To learn the programming of Micro Processor.

Unit-I Number Systems, codes, digital electronics: Logic Gates, combinational circuits design, Flip-flops, Sequential logic circuits design: Counters, Shift registers.

Unit-II Introduction to 8085 Functional Block Diagram, Registers, ALU, Bus systems, Timing and control signals.

Unit-III Machine cycles, instruction cycle and timing states, instruction timing diagrams, Memory interfacing.

Unit-IV Assembly Language Programming: Addressing modes, Instruction set, simple programs in 8085; Concept of Interrupt, Need for Interrupts, Interrupt structure, Multiple Interrupt requests and their handling, Programmable interrupt controller; Interfacing peripherals: Programmable peripheral interface (8255).

Unit-V Interfacing Analog to Digital Converter & Digital to Analog converter, Multiplexed seven segments LED display systems, Stepper Motor Control, Data Communication: Serial Data communication (8251), Programmable Timers (8253); 8086/8088 Microprocessor and its advanced features, Introduction to Digital Control: Sampling theorem, Signal conversion and Processing, Z-Transform, Digital Filters, Implementation of Digital Algorithm.

TEXT BOOKS

1. Digital Electronics: An Introduction to Theory and Practice, William H. Gothmann, PHI Learning Private Limited
2. Digital Computer Electronics: An Introduction to Microcomputers, Albert Paul Malvino, Tata McGraw-Hill Publishing Company Ltd.

REFERENCES

1. Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh Gaonkar, PENRAM International Publishers.
2. Digital Control Systems, Benjamin C. Kuo, Oxford University Press (2/e, Indian Edition, 2007).
3. Microcomputer Experimentation with the Intel SDK-85, Lance A. Leventhal, Prentice Hall

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

1. Able to perform numerical conversions
2. Learn the basic elements of microprocessor
3. Understand the working of basic 8085 microprocessor
4. Write assembly language programs
5. Provide good idea of the use of microprocessors in automation.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓										✓
CO2	✓		✓		✓							✓
CO3	✓		✓		✓							✓
CO4	✓	✓	✓	✓								✓
CO5	✓	✓	✓			✓						✓

MEPESCN	COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To understand the mechanical behaviour of composite materials
- To get an overview of the methods of manufacturing composite materials

Unit-I Definition and applications of composite materials, Fibers-glass, carbon, ceramic and aramid fibers; Matrices-polymer, graphite, ceramic and metal matrices; characteristics of fibers and matrices.

Unit-II Lamina-assumptions, macroscopic viewpoint, generalized Hookes law, reduction of homogeneous orthotropic lamina, isotropic limit case, orthotropic stiffness matrix, commercial material properties, rule of mixtures, transformation matrix, transformed stiffness.

Unit-III Manufacturing of composite materials, bag moulding, compression moulding, pultrusion, filament welding, other manufacturing processes Basic assumptions of laminated anisotropic plates, symmetric laminates, angle ply laminates, cross ply laminates, laminate structural moduli, evaluation of lamina properties, determination of lamina stresses, maximum stress and strain criteria, von Mises Yield criterion for isotropic materials, generalized Hill's criterion for anisotropic materials, Tsai-Hill's criterion for composites, prediction of laminate failure, thermal analysis of composite laminates Analysis of laminated plates- equilibrium equations of motion, energy formulation, static bending analysis, buckling analysis, free vibrations, natural frequencies

Unit-IV Metal Matrix Composites: Characteristics of MMC, Various types of Metal matrix composites Alloy vs. MMC, Advantages of MMC. Limitations of MMC, Metal Matrix, Reinforcements particles- fibres. Effect of reinforcement - Volume fraction - Rule of mixtures, Processing of MMC - Powder metallurgy process - diffusion bonding - stir casting, squeeze casting

Unit-V Ceramics Matrix Composites: Engineering ceramic materials - properties - advantages - limitations - Monolithic ceramics - Need for CMC Ceramic matrix - Various types of Ceramic Matrix composites - oxide ceramics - non oxide ceramics aluminium oxide - silicon nitride - reinforcements particles - fibres - whiskers. Sintering - Hot pressing Cold isostatic pressing (piping) - Hot isostatic pressing. (HIPing).

TEXT BOOKS

1. Gibson R.F. Principles of Composite Material Mechanics, second edition, McGraw Hill, 1994.
2. Hyer M.W., Stress Analysis of Fiber- Reinforced Composite Materials, McGraw Hill, 1998.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

1. Know the basics of composites
2. Learn the rules for attaining a good composite
3. Understand the various methods of composites manufacture
4. Learn the powder metallurgy technique
5. Learn the properties of ceramic composites

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓		✓									✓
CO2	✓	✓										✓
CO3	✓				✓							✓
CO4	✓		✓									✓
CO5	✓		✓			✓						✓

MEPESCN	**COMPUTER AIDED DESIGN AND MANUFACTURING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To provide an overview of how computers can be utilized in mechanical component design
- To learn the principles of CAD/CAM.

Unit-I Fundamentals of Computer Graphics- Product cycle, sequential and concurrent engineering, Computer Aided Design, CAD system architecture, computer graphics, Coordinate systems, 2D and3D transformations, viewing transformation

Unit-II Geometric Modeling- representation of curves, Hermite curves, Bezier curves, B-spline curves, rational curves, Techniques of surface modelling, surface patch, Coons and bicubic patches, Bezier and B-spline surfaces, Solid modelling techniques, CSG and B-rep. Visual realism- hidden line-surface-solid removal algorithms, shading, colouring, computer animation

Unit-III Assembly of parts- assembly modelling, interferences of positions and orientation, tolerance analysis, mass property calculations, mechanism simulation and interference checking CAD standards- Graphical Kernel System (GKS), standards for exchange images, Open Graphics Library (OpenGL), Data exchange standards- IGES, STEP, CALS etc., Communication standards

Unit- IV

Computer Aided Manufacturing- Numerical Control - Introduction - Basic Components of NC system, NC procedures, NC Co-ordinates, NC motion control systems,, NC languages- Programming, Voice NC programming - Working of Computer Numerical Control, Direct Numerical Control and Adaptive control. Advantages and Disadvantages of NC, CNC, DNC, Trends and developments in NC.

Unit- V

Computer Integrated Manufacturing- Flexible Manufacturing system, Group Technology - Part families, part classification and coding - Production flow analysis - machine cells , design automation - Computer aided process planning - IMS components - application- Automated production.

TEXT BOOKS

1. M. P. Groover, E.W. Zimmers. CAD/CAM - Computer Aided Design and Manufacturing, Pearson Education Pvt. Ltd, 2013.
2. Ibrahim Zeid, Mastering CAD CAM, Tata McGraw Hill Publishing Co. 2007.

REFERENCES

1. C. McMohan and J. Browne, CAD/CAM Principles, II edition, Pearson Education, 1999.
2. D. Hearn and M.P> Baker, Computer Graphics, Prentice Hall Inc., 1992

COURSE OUTCOMES

Upon completion of this course, the students will be able to

1. Learn the fundamentals of CAD
2. Use computer and CAD software for modeling mechanical components
3. Check CAD standards
4. Understand the basics of computer aided manufacturing
5. Understand the basics of computer integrated manufacturing

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓		✓		✓						✓	✓
CO2	✓		✓		✓						✓	✓
CO3	✓		✓		✓						✓	✓
CO4	✓		✓		✓						✓	✓
CO5	✓		✓		✓						✓	✓

MEPESCN	**REFRIGERATION AND AIR CONDITIONING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To familiarize with the terminology associated with refrigeration systems and air conditioning To understand basic refrigeration processes
- To understand the basics of psychrometry and practice of applied psychrometrics
- To acquire the skills required to model, analyse and design different refrigeration as well as air conditioning processes and components

Unit–I Introduction – Unit-of refrigeration – Refrigeration systems – Refrigeration cycles and concepts – Coefficient of Performance – Reversed Carnot cycle – Refrigeration System - Heat pump – Air Refrigeration – types – problems – Air craft Refrigeration system (Description only).

Unit–II Introduction to Steam Jet Refrigeration, vapour absorption refrigeration and solar refrigeration – (Description only) – performance Analysis of vapour compression cycle – Ideal and actual conditions – Problems – Representation of cycle on p-h and T-s diagram – Properties of refrigerants and their choice for different applications – Eco friendly refrigerant.

Unit–III Refrigeration equipment – (Description only) – Compressors – Reciprocating, centrifugal and screw – open, hermetic and semi-hermetic Units – condensers – air and water cooled condensers, evaporative condensers – Evaporators – Double tube, shell and tube, dry and flooded types – Expansion devices – Protection devices – High and Low pressure cut out Thermostat – solenoid valve.

Unit–IV Psychrometry of Air conditioning Processes – sensible heating and cooling, latent heat process, total heat process, sensible heat factor – bypass factor – cooling and Dehumidifying coil, heat coils, air washer, adiabatic dehumidifiers, water and steam injection – Adiabatic mixing – Problems on Psychrometric processes.

Unit–V Air-conditioning system – classification – Unitary, packaged and central type summer and winter air conditioning systems – (Description only) – merits and demerits – Comfort indices – Air purification – Air-conditioning – Heat gain and load calculations – RSHF, GSHF and ERSHF – energy efficiency in building – Need for reheating.

TEXT BOOKS

1. Arora, C.P., "Refrigeration and Air Conditioning", McGraw Hill, 3rd ed, New Delhi, 2010.
2. R.S. Khurmi & J.K. Guptha, Refrigeration and Air-Conditioning, S.Chand & company, 3rd ed, New Delhi, 2005.

REFERENCES

1. Gosney, W.B, Principles of Refrigeration, Cambridge University Press, 1982.
2. Stoecker, W.F. and Jones, J.W., Refrigeration and Air conditioning, Tata McGraw Hill, 1986.
3. Arora, C.P., Refrigeration and Air conditioning, Tata McGraw Hill, 2nd Edition, 2000.
4. Kuehn, T.H., Ramsey, J.W. and Threlkeld, J.L., Thermal Environmental Engineering, 3rd Edition, Prentice Hall, 1998.
5. Arora, S.C. & Domkundwar, S., Refrigeration and Air-conditioning, Dhanpat Rai & Sons, NewDelhi, 1995.
6. Stoecker, W.F. and Jones J. W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi, 1986.
7. Ballaney, P.L., Refrigeration and Air-conditioning, Khanna Publisher, New Delhi, 2003.
8. Roy J. Dossat, "Principles of Refrigeration", Pearson Education Asia, 4th ed, 2009.
9. "ASHRAE Hand book", Fundamentals 2010.

COURSE OUTCOMES

Upon completion of this course the student will able to

1. Understand the components of refrigeration and air conditioning systems
2. Understand the psychrometry of mixture of water vapor and air.
3. Understand the working principles of refrigeration and air-conditioning systems.
4. Understand the need for pure air
5. Know the current trends in HVAC systems

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓		✓									✓
CO2	✓		✓									✓
CO3	✓		✓									✓
CO4	✓		✓									✓
CO5	✓		✓									✓

MEPESCN	FINITE ELEMENT ANALYSIS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To illustrate the principle of mathematical modeling of engineering problems
- To introduce the basics and application of Finite Element Method

Unit-I Historical Background, Basics of FEA, FEM applications. General field problems in engineering, Modeling — discrete and continuous models, difficulties involved in solution-relevance and place of FEM. Boundary and initial value problems

Unit-II Weighted Residual Methods, Variational formulation of boundary value problems, Ritz technique, Basic concept of Finite Element Method. Simultaneous Linear equation – Gauss elimination, Choleskeys factorization and Gauss seidel iterative methos.

Unit-III One dimensional second order equation, discretization, linear and higher order elements, derivation of shape functions, Stiffness matrix and force vectors, assembly of elemental matrices, solution of problems from solid mechanics and heat transfer, longitudinal vibration and mode shapes, fourth order beam equation, transverse deflections and natural frequencies.

Unit-IV Two dimensional equations, variational formulation, finite element formulation, triangular elements shape functions, elemental matrices and RHS vectors; application to thermal problems, torsion of non-circular shafts, quadrilateral and higher order elements. Plane stresses and plane strain problems, body forces and thermal loads, plate and shell elements.

Unit-V Natural coordinate systems, isoparametric elements and shape functions, numerical integration and application to plane stress problems, matrix solution techniques, solution of dynamic problems, introduction to FE software.

TEXT BOOKS

1. Reddy J.N., An Introduction to Finite Element Method, 3rd ed., Tata McGraw Hill, 2005.
2. Seshu P., Text Book of Finite Element Analysis, Prentice Hall, New Delhi, 2007.

REFERENCES

1. Rao S.S., The Finite Element Method in Engineering, 3rd ed., Butterworth Heinemann, 2004.
2. Chandraputla & Belegundu, Introduction to Finite Elements in Engineering, 3rd ed., Prentice Hall, 1990.

COURSE OUTCOMES

Upon completion of the course, students will be able to

1. Understand the FEM formulation
2. Solve simple structural and thermal problems
3. Formulate problems on natural vibrations
4. Generate problems on torsional objects
5. Introduce software available for analysis

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓			✓	✓							
CO2	✓			✓	✓							
CO3	✓			✓	✓							
CO4	✓			✓	✓							
CO5	✓			✓	✓							

MEPESCN	**POWER PLANT ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To provide an overview of power plants and the associated energy conversion issues
- To learn the basic components of power plants

Unit-I Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers, steam and heating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems

Unit-II Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems.

Unit-III Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants.

Unit-IV Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems

Unit-V Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants.

TEXT BOOKS

1. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2008.
2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.

REFERENCES

1. Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.

COURSE OUTCOMES

Upon completion of the course, the students will be able to

1. Understand the principles of operation of coal based power plant
2. Learn the working of gas power plants
3. Basics of nuclear reactors

4. Understand various non conventional power plants
5. Gain knowledge on power plant economics.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓			✓								✓
CO2	✓			✓								✓
CO3	✓			✓								✓
CO4	✓			✓								✓
CO5	✓			✓								✓

MEPESCN	**GAS DYNAMICS AND JET PROPULSION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the features of compressible isentropic flows and irreversibilities like shocks.
- To provide a basic knowledge of jet and rocket propulsion technologies.

Unit-I Compressible flow, definition, Mach waves and Mach cone, stagnation states, Mass, momentum and energy equations of one-dimensional flow, Isentropic flow through variable area ducts, nozzle s and diffusers, subsonic and supersonic flow I variable area ducts, choked flow, Area-Mach number relations for isentropic flow

Unit-II Non-isentropic flow in constant area ducts, Rayleigh and Fanno flows.

Unit-III Normal shock relations, oblique shock relations, isentropic and shock tables

Unit-IV Theory of jet propulsion, thrust equation, thrust power and propulsive efficiency, Operating principle and cycle analysis of ramjet, turbojet, turbofan and turboprop engines.

Unit-V Types of rocket engines, propellants & feeding systems, ignition and combustion, theory of rocket propulsion, performance study, staging, terminal and characteristic velocity, space flights.

TEXT BOOKS

1. Ahmed F. El-Sayed, Aircraft Prpoulsion and Gas Turbine Engines, CRC Press, 2008.
2. H.S. Mukunda, “Understanding Aerospace Chemical Propulsion”, Interline Publishing, 2004.

REFERENCES

1. Hill P. and Peterson C., Mechanics & Thermodynamics of Propulsion, Addison Wesley, 1992.
2. Zucrow N. J., Aircraft and Missile Propulsion, Vol.I& II, John Wiley, 1975.
3. Sutton G.P., Rocket Propulsion Elements, John Wiley, New York, 1986.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

1. Understand the basics of gas dynamics
2. Learn the basics of non-isentropic flow
3. Understand the need for shocks

4. Learn the operating principle of jet operation
5. Apply gas dynamics principles to jet and space propulsion systems

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓			✓								
CO2	✓	✓	✓	✓								
CO3	✓					✓						✓
CO4	✓					✓						✓
CO5	✓		✓	✓								✓

MEPESCN	**PROCESS PLANNING AND COST ESTIMATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To introduce process planning concepts to make cost estimation for various products
- To learn the basics of cost estimatation.

Unit-I Introduction of Process Planning- methods of process planning, drawing interpretation, material evaluation, steps in process selection, production equipment and tooling selection

Unit-II Process planning activities- process parameter calculation for various production processes, selection of jigs and fixtures, selection of quality assurance methods, documents for process planning, economics of process planning, case studies

Unit-III Introduction to cost estimation- importance of costing and estimation, methods of costing, elements of cost estimation, types of estimates, estimating procedure, estimation of labor cost, material cost, allocation of overhead charges, calculation of depreciation cost

Unit-IV Machining time estimation- importance of machine time calculation, machining time for different lathe operations, drilling and boring time calculations, Machining time calculation for Milling, Shaping, Planing and Grinding

Unit-V Production costs- different production processes for different jobs, estimation of forging cost, estimation of welding cost, estimation of foundry cost, estimation of machining cost

TEXT BOOKS

1. Peter Scalon, Process Planning, Design/ Manufacture Interface, Elsevier Sci.& Tech. 2002.
2. Ostwaal P.F. and Munez J., Manufacturing Processes and Systems, 9th ed., John Wiley 1998.

REFERENCES

1. Chitale A.V. and Gupta R.C., Product Design and Manufacturing, 2nd ed., Prentice Hall 2002.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

1. Understand the basics of process planning

2. Detain economics of process planning
3. Learn the economics of cost estimation
4. Calculate machining time
5. Calculate production cost

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓		✓					✓			✓	
CO2	✓		✓					✓			✓	
CO3	✓		✓					✓			✓	
CO4	✓		✓					✓			✓	
CO5	✓		✓					✓			✓	

MEPESCN	**PRINCIPLES OF MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the principles of management and their application to the functioning of an organization
- To learn the purpose of planning and Organizing

Unit-I Definition of management, science or art, manager vs entrepreneur; Types of managers-managerial roles and skills; Evolution of management- scientific, human relations, system and contingency approaches; Types of Business Organizations, sole proprietorship, partnership, company, public and private enterprises; Organization culture and environment; Current trends and issues in management.

Unit-II Nature and purpose of Planning, types of Planning, objectives, setting objectives, policies, Strategic Management, Planning Tools and Techniques, Decision making steps & processes.

Unit-III Nature and purpose of Organizing, formal and informal organization, organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization, job design, human resource management, HR planning, Recruitment selection, Training & Development, Performance Management, Career planning and Management.

Unit-IV Directing, individual and group behavior, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment, leadership, types & theories of leadership, effective communication.

Unit-V Controlling, system and process of controlling, budgetary and non-budgetary control techniques, use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting.

TEXT BOOKS

1. Robins S.P. and Couiter M., Management, Prentice Hall India, 10th ed., 2009.
2. Stoner JAF, Freeman RE and Gilbert DR, Management, 6th ed., Pearson Education, 2004.

REFERENCES

1. Tripathy PC & Reddy PN, Principles of Management, Tata McGraw Hill, 1999.

COURSE OUTCOMES

Upon completion of this course, the students will e able to

1. Gain knowledge on the current trends in management
2. Learn the purpose of planning
3. Understand the need for organizing
4. Learn various leadership theories
5. Apply computers in management for an effective organization

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓							✓			✓	✓
CO2	✓							✓			✓	✓
CO3	✓							✓			✓	✓
CO4	✓							✓			✓	✓
CO5	✓							✓			✓	✓

MEPESCN	**AUTOMOBILE ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the construction and working principle of various parts of an automobile
- To learn the present scenario of Indian Automotive industry.

Unit-I Types of automobiles, vehicle construction and layouts, chassis, frame and body, vehicle aerodynamics, IC engines-components, function and materials, variable valve timing (VVT). Present Scenario of Indian Automotive industry.

Unit-II Engine auxiliary systems, electronic injection for SI and CI engines, Unit-injector system, rotary distributor type and common rail direct injection system, transistor based coil ignition & capacitive discharge ignition systems, turbo chargers (WGT, VGT), engine emission control by 3-way catalytic converter system, Emission norms (Euro & BS).

Unit-III Transmission systems, clutch types & construction, gear boxes- manual and automatic gear shift mechanisms, Over drive, transfer box, flywheel, torque converter, propeller shaft, slip joints, universal joints, differential and rear axle, Hotchkiss drive and Torque tube drive.

Unit-IV Steering geometry and types of steering gear box, power steering, types of front axle, types of suspension systems, pneumatic and hydraulic braking systems, antilock braking system (ABS), electronic brake force distribution (EBD) and traction control.

Unit-V Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in automobiles, modifications needed, Electric and Hybrid vehicles, application of Fuel Cells in automobiles.

TEXT BOOKS

1. Kirpal Singh, Automobile Engineering, 7th ed., Standard Publishers, New Delhi, 1997.
2. Jain K.K. and Asthana R.B., Automobile Engineering, Tata McGraw Hill, New Delhi, 2002.

REFERENCES

1. Heitner J., Automotive Mechanics, 2nd ed., East-West Press, 1999.
2. Heisler H., Advanced Engine Technology, SAE International Publ., USA, 1998.

COURSE OUTCOMES

Upon completion of this course, students will be able to

1. Gain the basics of automobile
2. Learn the fuel injection systems used in CI and SI engines
3. Learn the transmission systems
4. Learn various braking systems used in automobiles
5. Gain knowledge in the present trends in automobiles.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO6**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓					✓						✓
CO2	✓					✓						✓
CO3	✓					✓						✓
CO4	✓					✓						✓
CO5	✓					✓						✓

MEPESCN	DESIGN OF TRANSMISSION SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To gain knowledge on the principles and procedures for the design of power
- Transmission components.
- To understand the standard procedure available for Design of transmission systems
- To learn to use standard data and catalogues

Unit–I Bearings: - Hydrodynamic Journals Bearings - Design procedure - Minimum film thickness - Selection of Antifriction bearings - Life of bearings - Equivalent load, Cubic mean load - load rating - Design Procedure..

Unit–II Belt Drives of flat belts, V-Belts using manufacturer's table - Matched set of V-Belts, Chain drives for Power transmission design procedure.

Unit–III Gear drives: Toothed gear - types of failure - Design analysis - Gear Materials - Design of spur and Helical gears based on surface strength and bending strength - Forces acting on toothed gears.

Unit–IV Bevel and worm gears: Bevel gears classification - terminology - forces on bevel gear tooth - Design procedure - working gears - Design of worm gears - Terminology - centre distance - losses - design procedure.

Unit–V Gear Box: Standard Step ratio - Speed diagram - Kinematics layout - Design of six speed, twelve speed, eighteen speed gear box - calculation of actual speed.

TEXT BOOKS

1. R.S. Khurmi, "Machine Design", S. Chand company Ltd., 14th ed. 2005.
2. T.J. Prabhu, "Design of Transmission Elements", 4th ed. 2000.

REFERENCES

1. Richard Bundya and Shigley, "Mechanical Engineering Design", McGraw Hill Book Company.
2. T.V. Sundarajamoorthy, N.Shanmugham, "Machine Design", Khanna Publishers.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

1. Develop knowledge on the functions of various transmission elements.
2. Understand prerequisite for design of various transmission components.
3. Implement the basic engineering knowledge.
4. Work in the design team analyzing difficulties.
5. Design and develop solutions of various elements.

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓	✓	✓									
CO2	✓	✓	✓									
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

MEPESCN	**TOTAL QUALITY MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To facilitate the understanding of total quality management principles and processes
- To understand the various tools and techniques of TQM.

Unit-I Introduction, need for quality, evolution of quality; Definitions of quality, product quality andservice quality; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby. Barriers to TQM; Quality statements, customer focus, customer orientation & satisfaction, customer complaints, customer retention; costs to quality.

Unit-II TQM principles; leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCE cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection.

Unit-III The seven traditional tools of quality; New management tools; Six sigma- concepts, methodology, applications to manufacturing, service sector including IT, Bench marking process; FMEA- stages, types.

Unit-IV TQM tools and techniques, control charts, process capability, concepts of six sigma, Quality Function Development (QFD), Taguchi quality loss function; TPM- concepts, improvement needs, performance measures.

Unit-V Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation; Quality auditing, QS 9000, ISO 14000- concepts, requirements and benefits; TQM implementation in manufacturing and service sectors.

TEXT BOOKS

1. Besterfield D.H. et al., Total quality Management, 3rd ed., Pearson Education Asia, 2006.
2. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning, 2012.

REFERENCES

1. Janakiraman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.
2. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

1. Learn the basics of TQM
2. Understand the principles of TQM
3. Understand six sigma concept
4. Learn the tools and techniques of TQM
5. Know quality standards

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓				✓						✓	
CO2	✓				✓						✓	
CO3	✓				✓						✓	
CO4	✓				✓						✓	
CO5	✓				✓						✓	

MEPESCN	**ENERGY CONSERVATION AND MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the energy data from industries and carry out energy audit for energy savings
- To understand the world energy scenario.

Unit-I Introduction to energy & power scenario of world, National Energy consumption data, environmental aspects associated with energy utilization; Energy Auditing- need, types, methodology and barriers, role of energy managers, instruments of energy auditing.

Unit-II Components of EB billing, HT and LT supply, transformers, cable sizing; Concept of capacitors, power factor improvement, harmonics; Electric motors- motor efficiency computation, energy efficient motors; Illumination- Lux, Lumens, types of lighting, efficacy, LED lighting and scope of energy conservation in lighting.

Unit-III Thermal systems, Boilers, Furnaces and Thermic Fluid heaters- efficiency computation and energy conservation measures; Steam distribution and usage, steam traps, condensate recovery, flash steam utilization; Insulation & Refractories.

Unit-IV Energy conservation in major utilities; pumps, fans, blowers, compressed air systems, Refrigeration & Air Conditioning systems, Cooling Towers, DG sets.

Unit-V Energy Economics- discount period, payback period, internal rate of return, net present value; Life Cycle costing- ESCO concept.

TEXT BOOKS

1. Witte L.C., Schmidt P.S. and Brown D.R., Industrial Energy Management and Utilization, Hemisphere Publ., Washington, 1988..
2. Callaghn P.W., Design and Management for Energy Conservation, Pergamon Press, Oxford, 1981.

REFERENCES

1. Murphy W.R. and McKay G., Energy Management, Butterworths, London, 1987.
2. Energy Manager Training Manual, Bureau of Energy Efficiency (BEE) under Ministry of Power, GOI, 2004 (available at www.energymanager training.com).

COURSE OUTCOMES

Upon completion of this course, the students will be able to

1. Understand the world power scenario
2. Learn the scope for energy conservation
3. Perform energy audit in thermal systems
4. Perform energy auditing for the energy consumption of industries.
5. Learn the energy economics

Mapping of COs with POs												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO6**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	✓		✓			✓	✓					✓
CO2	✓		✓			✓	✓					✓
CO3	✓		✓			✓	✓					✓
CO4	✓		✓			✓	✓					✓
CO5	✓		✓			✓	✓					✓

OPEN ELECTIVE COURSES

MEOESCN	**AUTOMOTIVE ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**0**

COURSE OBJECTIVES

To impart knowledge to students in about an overall understanding of Automobile Engineering and to under stand

- Classification and layouts of different vehicles
- Different types of Engines in use
- Different types of clutch, gear box and transmission used
- Different types of brakes, drivelines and wheels and tyres

Unit-I - Vehicle Classification and Layouts

Study various vehicle layouts as front engine & front wheel drive, front engine & rear wheel drive, rear engine & rear wheel drive. Classification based on controls positioning. Types of Chassis frames & construction of Chassis frame and vehicular Body

Unit-II - Engine Types (Based on Fuel Used)

Gasoline, Diesel, LPG, CNG, Bio-Diesel (Basic study)

Unit-III - Clutch, Transmission and Brakes

Functions and type of clutches, single plate, multiple plates, centrifugal. Vehicle motion, resistances during motion, accelerated and constant velocity motions, tractive force, gradeabilty, power required and engine characteristics, gear ratio requirement. Manual Gear Boxes - Sliding mesh, constant mesh, synchromesh, epicyclical gear boxes, gear ratios, Automatic transmission. Service Brakes - Function, Internal expanding brakes, shoes and lining material, properties, hydraulic braking system, brake oil, bleeding of brakes, pneumatic braking system and vacuum brakes. Auxiliary Brakes - Exhaust brakes, parking brake.

Unit-IV - Steering, Front Axle and Suspension
Steering requirements, steering gears box types, steering system and linkages, steering geometry, wheel alignment, toe-in, toe-out, caster, camber, power steering. Purpose of front and rear suspension, types of suspension system, coil spring, leaf spring, torsion bars, shock absorbers, air suspensions, independent suspension and McPherson strut .

Unit-V - Drive Line, Rear Axles and Wheels and Tyres
Propellers shaft, final drive types, Bevel, hypoid, Drive axles & differential, fully or semi-floating and three quarter floating, dead axle. Types of wheel, rims, tread patterns of tyre, tubeless tyres, specifications of tyres.

TEXT BOOKS
1. Dr. Kirpal Singh, "Automobile Engineering (Volume – 1&2)", 12th Edition, Standard Publishers Distributors, 2011.
2. Rajput.R.K, "A Text Book of Automobile Engineering", Laxmi Publications (P) Ltd, 2007.

REFERENCES
1. Kamaraju Ramakrishna, "Automobile Engineering", Printice Hall of India, 2012
2. Donald L Anglin, William H Crouse.

COURSE OUTCOMES
Upon completion of this course, students will be able to
1. Gain the basics of automobile
2. Learn the fuel injection systems used in CI and SI engines
3. Learn the transmission systems
4. Learn various braking systems used in automobiles
5. Gain knowledge in the present trends in automobiles.

MEOESCN	AUTOMOTIVE SAFETY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES
The course should enable the students to:
- Know about the basics about the vehicle
- Understand the safety aspects in the vehicle.
- Know and understand the various safety aspects.
- To get the knowledge in sensors provided in the vehicle to avoid the crash and to detect the defects in the vehicle.

Unit-I Introduction
Automotive safety: Introduction, Types. Active safety: driving safety, conditional safety, perceptibility safety, operating safety. Passive safety: exterior safety, interior safety.

Unit-II Passive Safety Concepts
Design of body for safety, deceleration of vehicle, passenger. Concept of crumble zone, Safety Cage. Optimum crash pulse, deceleration on impact with stationary and movable obstacles. Deformation behavior of vehicle body. Deformation behavior of Lightweight materials.

Unit-III Passive Safety Equipments and Convenience System
Seat belt, Seat belt tightener system and importance, collapsible steering column. Air bags and its activation. Designing aspects of automotive bumpers and materials for bumpers. Steering and mirror adjustment, central locking system, Tire pressure control system, rain sensor system, automated wiper system.

Unit-IV Active Safety
Antilock braking system, Stability Control. Adaptive cruise control, Lane Keep Assist System, Collision warning, avoidance system, Blind Spot Detection system, Driver alertness detection system.

Unit-V Vehicle Integration and Navigation System
Looking out sensors and Looking in sensors, Intelligent vision system, Vehicle Integration system. Global Positioning System. Vehicle Navigation System. Road Network,

TEXT BOOKS
1. Ljubo Vlacic, Michel Parent, Fumio Harashima –"Intelligent Vehicle Technologies Theory and Applications" -Butterworth-Heinemann, 2001
2. J. Marek, H.-P. Trah, Y. Suzuki, I. Yokomori -"Sensors for Automotive Applications "-WILEYVCH Verlag GmbH & Co. 2003

REFERENCES
1. Robert Bosch GmbH -"Safety, Comfort and Convenience Systems"-Wiley; 3rd edition, 2007
2. Bosch, "Automotive Hand Book", 6th edition, SAE, 2004.
3. J.Powloski -"Vehicle Body Engineering" -Business books limited, London -1969.
4. Ronald.K.Jurgen -"Automotive Electronics Handbook" -Second edition- McGraw -Hill Inc., - 1999.
5. ARAI Safety standard

COURSE OUTCOMES
The students should be able to:
1. Importance of safety in a automobile.
2. Know about the concept of crumble zone, and also the effect of acceleration and deceleration of the vehicle in the compartment of the vehicle.
3. Know the various types of safety aspects such as active and passive safety, the active safety components and the working passive safety components such as air bags, seat belts
4. Know the working of the compartment while moving of the vehicle, about the collapsible steering and tiltable steering column, about the collision avoidance system, front and rear object detection.
5. Know about the rear vehicle detection system, and the braking system, the comfort and convenience system for the vehicle such as central locking system, garage door opening system and about the environment information system.

MEOESCN	ELECTRIC AND HYBRID VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES
- To understand the basic concept of Hybrid, Electric Vehicles, energy Storage devices and controls.
- To learn the various energy storage devices

Unit-I Introduction to Need for Alternative System

History of electric and hybrid vehicles. Need of electric and hybrid vehicles – comparative study of diesel, petrol, electric and hybrid vehicles. Limitations of electric vehicles. Specification of different electric and hybrid vehicles.

Unit-II Energy Storage Devices and Fuel Cells

Electromechanical batteries- types of batteries –lead acid batteries, nickel based batteries, lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency and ultra-capacitors.

Fuel Cell- Fuel cell characteristics- Fuel cell types-Hydrogen fuel cell- Connecting cell in series- water management in the PEM fuel cell- Thermal Management of the PEM fuel cell

Unit-III Electric Vehicles

Electric vehicle layout, performance of electric vehicles – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, advantage and limitations, specifications, system components, electronic control system, safety and challenges in electric vehicles.

Unit-IV Hybrid Vehicles

Concepts of hybrid electric drive train, types, architecture of series and parallel hybrid electric drive train, merits and demerits, hybrid electric drive train design, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles.

Unit-V Propulsion Motors and Controllers

Types of electric motors – working principle of AC and DC motors. Characteristic of shunt, series and compound type of DC motors- permanent magnet and separately exited DC motors. AC single phase and 3-phase motor – inverters – DC and AC motor speed controllers.

TEXT BOOKS

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained “ John Wiley & Sons,2003
2. Iqbal Husain, “ Electric and Hybrid Vehicles-Design Fundamentals”, CRC Press,2003

REFERENCES

1. Ron Hod Kinson, “ light Weight Electric/ Hybrid Vehicle Design”, Butterworth Heinemann Publication,2005
2. Lino Guzzella, “ Vehicle Propulsion System” Springer Publications,2005
3. Mehrdad Ehsani, “ Modern Electric, Hybrid Electric and Fuel Cell Vehicles”, CRC Press,2005

COURSE OUTCOMES

Upon completion of this course, students will have deep knowledge on

1. Need for alternative systems
2. Basic of hybrid and electric vehicles
3. Different energy storage devices
4. Concepts of hybrid electric drive train
5. Electric motors and controllers

MEOESCN	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	0

COURSE OBJECTIVES

- To impart knowledge about various computational methods for fluid flow and heat transfer problems so as to enable the students to write computer programs for solving elementary fluid dynamics/heat transfer problems.
- Students will be exposed to governing equations required for CFD and their mathematical behavior.
- Students will be exposed to modeling of Fluid flow and heat transfer problem.

Unit-I - Governing Equations

Introduction — Various applications of CFD, Governing equations-continuity, momentum, energy equations, Boundary conditions

Unit-II - Fundamentals of Discretisation

Basics of FDM, FVM, FEM. Revision of Numerical Methods. Discretisation of Computational Domain

Unit-III - One Dimensional Unsteady State Problems

Explicit Vs Implicit and Semi- implicit Methods. Numerical Oscillations, Derivation of Stability Criterion. Guiding Principles Of FVM.

Unit-IV - Introduction to Convection

Upwind Differencing, False Diffusion, Significance of Peclet number.

Unit-V - Algorithms in CFD

Simple, Flow chart for Simple, Predictor- Corrector Methods, MAC Algorithm, TERM PROJECT.

TEXT BOOK

1. Anil Date: Introduction to CFD Cambridge University Press, 2005.
2. Versteeg.H.K and Malalasekera.W, " An Introduction to Computational Fluid Dynamics, the Finite Volume Method", Addison Wesley Longmen Limited, 1995

REFERENCES

1. Patankar.S.V, "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, 1980.

COURSE OUTCOMES

At the end of the course student can able to

1. Gain deep knowledge on the governing equations used in CFD
2. Understand the fundamentals of CFD
3. Able solve simple problems
4. Understand various algorithms used
5. Able to solve problems in CFD

MEOESCN	FINITE ELEMENT METHODS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To understand the basics of finite element analysis and its applications in engineering and to familiarize the

- Basics of Finite Element analysis
- Weighed Residual Methods for static analysis
- Different elements like truss, beam, triangular, quadrilateral and brick elements.
- Analysis of one dimensional and two dimensional problems with the help of software.

Unit-I - Introduction to Finite Element Analysis

Basics of FEA, historical background, FEM applications. General field problems in engineering, Modeling — discrete and continuous models, difficulties involved in solution- relevance and place of FEM. Boundary and initial value problems.

Unit-II - Calculus of Variations

Variational formulation in finite elements, Weighted residual methods-Galerkin method, sub domain method, method of least square and collocation method, numerical problems.

Unit-III - Static Analysis

General procedure of FEM, skeletal and continuum structures, descritization of domain, basic types of elements- truss, beam, triangular, quadrilateral and brick elements- shape functions, Rayleigh and Ritz method, formulation of element stiffness matrices -Isoparametric elements.

Unit-IV - Finite Element Analysis of One Dimensional Problems

One dimensional second order equations-generalized coordinate approach, derivation of element equation- assembly of element equation- imposition of boundary conditions- solution of equation-Cholesky method- extension of the method to fourth order equation- time dependent problems from heat transfer and solid mechanics-heat transfer through simple fins, composite wall, bending of beams.

Unit-V - Finite Element Analysis of Two Dimensional Problems

Global and natural coordinates, second order equations involving scalar valued function- model equation - variational formulation - finite element formulation through generalized coordinate approach — convergence criteria for chosen models interpolation functions- element matrices-problems on bending of plates and heat transfer in two dimensions.

TEXT BOOKS

1. Reddy.J.N, “An Introduction to Finite Element Method”, McGraw Hill International Editions,1 993
2. Chandrupatla and Bologundu., “Finite Elements in Engineering”, Prentice Hall of India Pvt. Ltd, 1997.

REFERENCES

1. Rao.S.S, “Finite Element Methods in Engineering”, Pregamon Press, 1989.
2. Krishnamoorthy.C .S, “Finite Element Analysis - Theory an d Programming”, T a t a M cGr aw Hill Publishing Co, 1987.
3. Zienkiewicz.O.C, “The Finite Element Method in Engg. Science”, McGraw Hill, London, 1977.

COURSE OUTCOMES

At the end of the course student can able to

1. Gain the basics of finite element analysis
2. Formulate problems in FEA
3. Understand the procedure of FEM
4. Analyze one dimension and two dimension problems
5. Understand the subject for a lifelong learning

MEOESCN	ENERGY MANAGEMENT IN BUILDINGS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To effectively manage energy in buildings
- To learn the basics of natural ventilation and air conditioning
- To determine the various building loads

Unit-I Introduction

Conventional versus Energy Efficient buildings – Historical perspective - Water – Energy – IAQ requirement analysis – Future building design aspects – Criticality of resources and needs of modern living

Unit-II Landscape and Building Envelopes

Energy efficient Landscape design - Micro-climates – various methods – Shading, water bodies- Building envelope: Building materials, Envelope heat loss and heat gain and its evaluation, paints, Insulation, Design methods and tools.

Unit-III Heating, Ventilation and Air-Conditioning

Natural Ventilation, Passive cooling and heating - Application of wind, water and earth for cooling, evaporative cooling, radiant cooling – Hybrid Methods – Energy Conservation measures, Thermal Storage.

Unit-IV Heat Transmission in Buildings

Surface co-efficient: air cavity, internal and external surfaces, overall thermal transmittance, wall and windows; Heat transfer due to ventilation/infiltration, internal heat transfer; Solar temperature; Decrement factor; Phase lag. Design of daylighting; Estimation of building loads: Steady state method, network method, numerical method, correlations; Computer packages for carrying out thermal design of buildings and predicting performance.

UNIT-V Passive Cooling & Renewable Energy in Buildings

Passive cooling concepts: Evaporative cooling, radiative cooling; Application of wind, water and earth for cooling; Shading, paints and cavity walls for cooling; Roof radiation traps; Earth air tunnel. Introduction of renewable sources in buildings, Solar water heating, small wind turbines, stand-alone PV systems, Hybrid system – Economics.

TEXT BOOKS

1. Krieder, J and Rabi, A., Heating and Cooling of buildings : Design for Efficiency, Mc Graw Hill, 1994.
2. Ursala Eicker, “Solar Technologies for buildings”, Wiley publications, 2003.

REFERENCES

1. Guide book for National Certification Examination for Energy Managers and Energy Auditors

COURSE OUTCOMES

Upon completion of the course, students will be able to

1. Understand the needs for modern living
2. Select proper materials for a effective energy management
3. Effectively manage energy in buildings
4. Understand the basics of HVAC system
5. Calculate the various building loads effectively

MEOESCN	RENEWABLE ENERGY TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To emphasis the current energy status and role of renewable energy sources.
- To familiarize various aspects of Solar energy and utilization
- To familiarize various aspects of Biomass energy and utilization
- To familiarize other renewable energy sources

Unit-I – Introduction

World energy status, Current energy scenario in India, Environmental aspects of energy utilization, Environment - Economy - Energy and Sustainable Development, Energy planning.Reserves of Energy resources, Renewable energy resources - potentials -achievements – applications. Technical and social implications, issues in grid integration of power from renewable energy sources.

Unit-II - Solar Energy

Basic concepts, Solar radiation – Measurement, Solar thermal systems – Flat plate and concentrating collectors, Solar passive space - Solar heating and cooling techniques – Solar desalination – Solar Pond - Solar cooker - Solar dryers-Solar furnaces - Solar pumping, Solar green house- Solar thermal electric power plant – Solar photo voltaic conversion – Solar cells – PV applications, Hybrid systems.

Unit-III - Wind Energy

Introduction-Availability- Wind power plants, Power from the wind, Wind energy conversion systems, site characteristics, Wind turbines types – Horizontal and vertical axis-design principles of wind turbine – Blade element theory, Magnus effect- Performance. Wind energy Applications – Hybrid systems, Wind energy storage, Safety and environmental aspects.

Unit-IV - Biomass Energy

Biomass – usable forms- composition- fuel properties – applications, Biomass resources, Biomass conversion technologies - direction combustion - pyrolysis – gasification -anaerobic digestion, Bioethanol and Biodiesel Production - Economics - Recent developments.Energy farming, Biogas technology - Family biogas plants, Community and institutional biogas plants – design consideration – applications.

Unit-V - Other Renewable Energy Sources

Tidal energy – Wave energy – Open and closed OTEC Cycles – Small hydro – Geothermal energy – Social and environmental aspects.Fuel cell technology - types, principle of operation – applications.Hydrogen energy production - Storage – transportation – utilization.

TEXT BOOKS

1. Godfrey Boyle, "Renewable Energy", Power for a Sustainable Future, Oxford University Press, U.K, 1996.
2. Twidell.J.W & Weir.A, "Renewable Energy Sources", EFN Spon Ltd., UK, 1986
3. Tiwari.G.N, "Solar Energy – Fundamentals Design", Modelling and applications, Narosa PublishingHouse,NewDelhi,2002

REFERENCES

1. Freris.L.L, "Wind Energy Conversion systems", Prentice Hall, UK, 1990.
2. Veziroglu.T.N, "Alternative Energy Sources", Vol 5 and 6, McGraw-Hill, 1978
3. Johnson Gary.L, "Wind Energy Systems", Prentice Hall, New York, 1985.
4. "Energy planning in Developed countries (U.N.)", Oxford University Press, 1984.
5. G.D. Rai, "Non Conventional Energy Sources", Khanna Publishers, New Delhi, 1999.
6. S.P. Sukhatme, "Solar Energy", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997
7. "Renewable energy sources of conversion technology:N.K Bansal", Manfred Kleen Man and Michael Meliss, TMH Publication.
8. Kothari P, K C Singal and Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", PHI Pvt. Ltd.,New Delhi, 2008

COURSE OUTCOMES

Upon completion of the course, students will be able to

1. Emphasis the current energy status and role of renewable energy sources.
2. Understand the various aspects of Solar energy and its utilization
3. Realize the significance of wind energy
4. Understand the bio energy conversion techniques
5. Learn the renewable energy resources

MEOESCN	INDUSTRIAL POLLUTION PREVENTION AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn various pollution norms
- To learn the various methods to curtail industrial pollution
- To learn the principles of water treatment

Unit-I - Sustainability

Industrial activity and environment, industrialization and sustainable development indicators of sustainability-sustainability strategies. Barriers to sustainability, Pollution prevention in achieving sustainability

Unit-II - Environmental Regulations

Prevention vs control of industrial pollution, Environment policies and Regulations to encourage pollution prevention, Environment friendly chemical processes, Regulations for clean environment and implications for industries

Unit-III - Pollution

Definition of pollutant, types of pollution; Air, Water, Land, noise- adverse effects of pollutants eco system and human health - need for effluent treatment and toxicity, control.Water standards for portable, agricultural and left-off streams- air standards for cities, industrial areas, resorts.

Unit-IV - Air Pollution Control Methods
Particulate emission control- gravitational settling chambers- cyclone separators, fabric filters, electrostatic precipitators, wet scrubbers, absorbers. Control of sulphur di oxide, oxides of nitrogen, carbon monoxide and hydrocarbons. Noise pollution measurements and its control.

Unit-V - Principles of Water Treatment
Primary, secondary and tertiary treatments - advanced waste water treatments;
recovery of metals from process effluents

TEXT BOOKS
1. Bishop.P, "*Pollution Prevention: Fundamentals and Practice*", McGraw Hill International Edn., McGraw Hill Book Co., Singapore, 2000
2. Freeman.H.M, "*Industrial Pollution Prevention Hand Book*", McGraw Hill,1995

REFERENCES
1. James. G. Mann and Liu.Y.A, "*Industrial Water Reuse and Waste Water Minimization*", McGraw Hill, 1999
2. Rose.G.R.D, "Air pollution and Industry", Van Nostrand Reinhold Co., NewYork 1972
3. Pandey.G.N and Carney.G.C, "Environmental Engineering", Tata McGraw Hill, New Delhi,1989
4. Kapoor.B.S, *"Environmental Engineering"*, 3rd Edn., Khanna publishers,1997

COURSE OUTCOMES
Upon completion of the course, students will be able to
1. Know the various methods available to suppress industrial pollution
2. Know the effects of water and air pollution
3. Know the various environmental regulations
4. Know the methods of mitigating air pollution
5. Know the basic principles of water treatment

MEOESCN	**POWER PLANT INSTRUMENTATION**	**L**	**T**	**P**	C
		3	**0**	**0**	**3**

COURSE OBJECTIVES
- To enable the student to gain a fair knowledge on various power plants & their related instruments.
- To get detailed knowledge on thermal power plant.
- To learn the measurements of various parameter in power plant and their control.

Unit-I - Overview of Power Generation
Brief survey methods of power generation hydro, thermal, nuclear, solar and wind power- Importance of instrumentation in power plants –Layout of Thermal power plant – Complete layout of Boiler and Turbine – Process and instrumentation diagram of thermal power plant – distributed digital control system in power plants.

Unit-II - Measurements in Power Plants
Use of transducers in electrical measurements-current, voltage, power, power factor - function of synchroscope – measurement of non-electrical parameters – flow of feed water, fuel, air and steam - measurement of steam pressure and temperature – Drum level measurement.

Unit-III - Analysers in Power Plants
Flue gas analysis – oxygen analyzer – CO analyzer – analysis of impurities in feed water and steam – conductivity and dissolved oxygen analyzers – Gas chromatography – PH meter – pollution monitoring instruments , smoke density measurements, dust monitor, radiation detector.

Unit-IV - Control Loops in Boiler
Combustion control – air/fuel ratio control- furnace draft control – drum level control – steam temperature control and attemperation –super heater control - Deaerator control - interlocks in boiler operation. UNIT-V - TURBINE

Unit-V - Turbine Monitoring and Control
Speed measurement, vibration and eccentricity measurement, shell temperature monitoring and control – lubricating oil temperature control – cooling system, protection and interlocks in turbines.

TEXT BOOKS
1. Sam G.Dukelow, "The control of Boilers", instrument society of America, 1991.
2. Krishnaswamy.K and M.Ponni Bala, "Power Plant Instrumentation", Eastern Economy Edition, 2011.

REFERENCES
1. Jain.R.K, "Mechanical and industrial Measurements", Khanna Publishers, New Delhi, 1995.
2. Elonka.S.M and Kohan.A.L, "Standard Boilers Operations", McGraw Hill, New Delhi, 1994.

COURSE OUTCOMES
Upon completion of the course, students will be able to
1. Gain detailed knowledge on thermal power plant.
2. Learn the measurements of various parameter in power plant and their control.
3. Understand the use of various analyzers in power plant
4. Know the various controls used in power plants
5. Learn the methodology of controlling turbines

MEOESCN	INTRODUCTION TO HYDRAULICS AND PNEUMATICS	L	T	P	C
		3	0	0	0

COURSE OBJECTIVES
- To study the basics of fluid power systems
- To learn the various hydraulic and pneumatic systems
- To study the applications of hydraulic and pneumatic systems

Unit-I - Basics of Fluid Power Systems
Fluid power- Introduction – types, Advantages , Applications. Properties of hydraulic fluids – General types of fluids – Fluid power symbols. Basics of Hydraulics- Sources of Hydraulic Power: Pumping theory – Pump classification Gear pump, Vane Pump, piston pump, construction and working of pumps –pump performance – Variable displacement pumps. seals and fittings.

Unit-II - Hydraulic Valves and Actuators
Construction of Control Components : Directional control valve- pressure control valve- electrical control solenoid valves, Relays. Fluid Power Actuators: Linear actuators- single, double, tandem and telescopic cylinders – Rotary actuators.

Unit-III - Pneumatic Systems and Components

Pneumatic Components: Properties of air – Compressors – Filter, Regulator, Lubricator Unit– Air control valves, Quick exhaust valves, pneumatic actuators. Fluidics –Introduction to fluidic devices, simple circuits.

Unit-IV - Design of Hydraulic and Pneumatic Circuits

Fluid Power Circuit Design- Speed control, synchronizing, Sequential circuit design for simple applications using cascade method. Electro Hydraulic Pneumatic logic circuits, ladder diagrams, PLC applications in fluid power control. Accumulators: Types, application circuits, sizing of accumulators, Intensifier circuit.

Unit-V- Application, Maintenance and Trouble Shooting

Hydraulic / pneumatic circuits: applied to machine tools, presses, material handling systems, automotive systems, packaging industries, manufacturing automation. Maintenance in fluid power systems – preventive and breakdown. Maintenance procedures. Trouble shooting of fluid power systems – fault finding process, equipments / tools used, causes and remedies. Safety aspects involved.

TEXT BOOKS

1. Anthony Esposito, “Fluid Power with applications”, Prentice Hall International, 2009.
2. Majumdar.S.R, “Oil Hydraulic Systems: Principles and Maintenance”, Tata McGraw Hill, 2006.

REFERENCES

1. Werner Deppert / Kurt Stoll, “Pneumatic Application:Mechanization and
2. Automation by Pneumatic Control”, Vogel verlag, 1986.
3. John Pippenger, Tyler Hicks, “Industrial Hydraulics”, McGraw Hill International Edition, 1980.
4. Andrew Parr, “Hydraulics and Pneumatics: A technician's and engineer's guide”, Elsevier Ltd, 2011.
5. FESTO, “Fundamentals of Pneumatics”, Vol I, II and III.
6. Hehn Anton, H., “Fluid Power Trouble Shooting”, Marcel Dekker Inc., NewYork, 1995.
7. Thomson, “Introduction to Fluid power”, Prentcie Hall, 2004.
8. Majumdar.S.R, “Pneumatic systems – principles and maintenance”, Tata McGraw-Hill, New Delhi, 2006.

COURSE OUTCOMES

Upon completion of the course, students will be able to

1. Understand the basics of fluid power systems
2. Learn the working of various hydraulic and pneumatic systems
3. Realize the applications of hydraulic and pneumatic systems
4. Design hydraulic circuits
5. Trouble shoot hydraulic devices

MEOESCN	BASIC THERMODYNAMICS AND HEAT TRANSFER	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To study the basics of thermodynamics
- To learn the various gas power cycles
- To study the basics of heat transfer and refrigeration

Unit-I - Basic Concepts of Thermodynamics

System - Ideal gas laws - Perfect gas, thermodynamic equilibrium, property, state, process, path and cycle, zeroth law of thermodynamics - Point and path functions - Quasi static process, reversible and irreversible processes. First law of thermodynamics, energy, work, heat, PMM1, applications of First law to closed and open systems. Pressure - Volume diagrams, steady flow process, applicationof steady flow energy equation.

Unit-II - Second Law of Thermodynamics

Limitations of first law, statements of second law of Thermodynamics, PMM II, Clausius inequality, heat engine, heat pump, refrigerator, Carnot cycle, Carnot theorem, entropy, temperature - Entropy diagram, entropy changes for a closed system. Third law of thermodynamics.

UNIT-III - Gas Power Cycles

Otto, Diesel, dual cycles: Efficiency, mean effective pressure, comparison. Introduction to Brayton cycle - Reheat and regeneration.

Unit-IV - Refrigeration and Air-Conditioning

Vapour compression refrigeration: Working principle, simple problems in vapour compression refrigeration cycle with sub-cooling and superheating. Introduction absorption system. Air-conditioning - Factors affecting air-to vapour conditioning, types of air-conditioning - Summer, winter, window and central air-conditioning.

Unit-V - Heat Transfer

Modes of heat transfer, steady state heat conduction - Plane wall, composite wall, hollow and composite cylinders. Overall heat transfer coefficient. Convection, empirical relations. Laws of radiations - Concept of block body Radiant heat transfer between two surfaces.

TEXT BOOKS

1. Rajput.R.K, "*Thermal Engineering"*, Lakshmi Publications, 2010.
2. Yunus A.Cengel, "*Introduction to Thermodynamics & Heat Transfer*", McGraw Hill Higher- Education, 2009.

REFERENCES

1. Kothandaraman.C.P, Domkundwar.S, Anand Domkundwar, *"A Course in*
2. *Thermal Engineering"*, Dhanpat Rai & Co. (P) Ltd., 2010.
3. Nag.P.K, *"Engineering Thermodynamics"*, Tata McGraw Hill, New Delhi, 2008.
4. Sarkar.B.K, "*Thermal Engineering"*, 3rd Edition, Tata McGraw Hill, New Delhi, 2009

COURSE OUTCOMES

Upon completion of the course, students will be able to

1. Know the basics of thermodynamics
2. Understand the various laws in thermodynamics
3. Learn the various gas power cycles and their applications
4. Understand the basics of refrigeration and air conditioning
5. Understand the various modes of heat transfer

MEOESCN	ENERGY AUDITING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To familiarize various forms of energy
- To understand energy management concepts
- To learn the methods of energy audit and usage of instruments
- To analyze and report the outcome of energy audit

Unit-I - Fundamentals of Energy

Basics of energy and its various forms: Conventional and non -conventional sources. Different fuels and its energy contents. Renewable energy - solar energy, wind energy, bio energy, hydro energy, geothermal energy, wave energy, tidal energy and OTEC.

Unit-II - Energy Management

Energy management- various approaches, cost effectiveness, bench marking, optimization of energy requirement and maximization of system efficiencies. Fuels and energy substitution.

Unit-III - Energy Audit

Energy audit – need, preliminary audit, detailed audit, methodology and approach. Instruments for audit, monitoring energy and energy savings.

Unit-IV - Assessment and Reporting

Evaluation of saving opportunities – determining the savings in INR, non- economic factors, conservation opportunities, estimating cost of implementation.

Unit-V Energy Audit Reporting - the plant energy study report, importance, effective organization, report writing and presentation.

TEXT BOOKS

1. Energy Management Audit & Conservation by Barun Kumar De Publisher: Vrinda Publications 2007
2. Hamies, Energy Auditing and Conservation: Methods, Measurements, Management & Case Study, Hemisphere, Washington, 1980.

REFERENCES

1. Energy Management: W.R.Murphy, G.Mckay (Butterworths).
2. Energy Management Principles: C.B.Smith (Pergamon Press)
3. Efficient Use of Energy: I.G.C.Dryden (Butterworth Scientific)
4. Energy Economics -A.V.Desai (Wieley Eastern)

COURSE OUTCOMES

Upon completion of the course, students will be able to

1. Gain knowledge on the fundamentals of energy
2. Understand various energy management concepts
3. Learn the methods of energy audit and usage of instruments
4. Asses the saving opportunities
5. Analyze and report the outcome of energy audit

MEOESCN	ENERGY CONSERVATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To encourage the students to learn

- Energy conservation principles.
- Energy conservation in steam systems.
- Energy conservation in fluid flow machinery.
- Electrical energy conservation measures.

Unit-I - Energy Conservation Principles

Energy scenario, principles of energy conservation, resource availability, energy savings, current energy consumption in India, roles and responsibilities of energy managers in industries.

Unit-II - Energy Conservation in Steam Systems

Power plant components, conservation measures in steam systems, losses in boiler, methodology of upgrading boiler performance - blow down control, excess air control, pressure reducing stations, condensate recovery , condensate pumping, thermo compressors, recovery of flash steam, air removal and venting, steam traps, cooling towers.

Unit-III - Energy Conservation in Fluid Machinery

Centrifugal pumps, energy consumption and energy saving potentials, design consideration, minimizing over design. Fans and blowers - specification, safety margin, choice of fans, controls and design considerations. Air compressor and compressed air systems, selection of compressed air layout, energy conservation aspects to be considered at design stage.

Unit-IV - Electrical Energy Conservation

Potential areas for electrical energy conservation in various industries, conservation methods, energy management opportunities in electrical heating, lighting system, cable selection, energy efficient motors, factors involved in determination of motor efficiency, adjustable AC drives, variable speed drives, energy efficiency in electrical system.

Unit-V - Energy Management

Organizational background desired for energy management persuasion, motivation, publicity role, tariff analysis, industrial energy management systems, energy monitoring, auditing and targeting, economics of various energy conservation schemes – energy policy and energy labeling.

TEXT BOOKS

1. Reay.D.A, “Industrial energy conservation”, Pergamon Press, 1st edition, 2003.
2. White.L.C, “Industrial Energy Management and Utilization”, Hemisphere Publishers, 2002.

REFERENCES

1. Smith.C.B, "Energy Management Principles", Pergamon Press, 2006.
2. Hamies, "Energy Auditing and Conservation; Methods, Measurements, Management and Case study", Hemisphere, 2003.
3. Trivedi.P.R and Jolka.K.R, "Energy Management", Common Wealth Publication, 2002.

COURSE OUTCOMES

Upon completion of the course, students will be able to

1. Learn the energy conservation principles
2. Know the modes of energy conservation in steam systems
3. Identify methods for energy conservation in a hydraulic system
4. Understand the electrical conservation measures.
5. Learn the concepts of energy management

MEOESCN	SOLAR ENERGY UTILIZATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To learn the operation of solar thermal energy systems
- Study of solar thermal power plants
- To study the components of solar photovoltaic power plants
- Utilization of solar energy in buildings

Unit-I - Solar Radiation

Sun and earth geometry, solar radiation-beam and diffuse radiations, measurement of solar radiation – pyranometer, pyrheliometer, sunshine recorder. Solar collectors and applications.

Unit-II - Solar Thermal Systems

Flat plate and evacuated tube collectors, domestic hot water and process heat systems, solar cooker, solar dryer, solar desalination and solar pond.

Unit-III - Solar Power Plant

Principles of solar parabolic concentrators-trough and dish types, compound parabolic concentrators, fresnel lens collectors, central receiver plant, direct steam generation systems, solar furnaces.

Unit-IV - Solar Photovoltaics

Solar photovoltaic theory, mono and polycrystalline silicon technologies, PV modules and integrated systems, implementation and maintenance.

Unit-V - Solar-Conscious Buildings

Orientation and design of buildings, passive solar heat- thermal capacity, insulation, solar cooling-refrigeration and air-conditioning, space heating, sensible and latent heat energy storages in buildings.

TEXT BOOKS

1. Sukhatme.K, Suhas P. Sukhatme, "Solar energy: Principles of thermal collection and storage", Tata McGraw Hill publishing Co. Ltd, 8th edition, 2008.
2. Soteris A. Kalogiru, "Solar Energy Engineering: Processes and systems", 1st edition, Academic press, 2009.

REFERENCES

1. Duffie.J.A, & Beckman.W.A, "Solar Engineering of Thermal Processes", 3rd edition, John Wiley & Sons, Inc., 2006.
2. Martin A. Green, "Third generation Photovoltaics: Advanced energy conversion", 1st edition, 2005.
3. Garg.H.P, Prakash.J, "Solar energy fundamentals and applications", Tata McGraw Hill publishing Co. Ltd, 2006.
4. Yogi Goswami.D, Frank Kreith, Jan F.Kreider, "Principle of solar engineering", 2nd edition, Taylor and Francis, 2nd edition, 2000.
5. Tiwari.G.N, "Solar energy: Fundamentals, Design, Modeling and Applications", CRC Press Inc., 2002.

COURSE OUTCOMES

Upon completion of the course, students will be able to

1. Understand the basic components and measuring devices
2. Know the operation of solar thermal energy systems
3. Understand the components of solar power plants
4. Emphasize the advantages of photovoltaic power plants
5. Learn the methods to effectively utilize solar energy in buildings

MEOESCN	WASTE HEAT RECOVERY SYSTEMS AND CO GENERATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- It deals with the difference cogeneration schemes and techno economics of co generation.
- It introduces difference ways heat recovery systems and thermodynamics aspects of waste heat recovery.

Unit–I Co-Generation:

Introduction-principles of thermodynamics, combined cycles, topping, bottoming, organic rankine cycles, advantages of cogeneration technology.

Unit–II Application and Techno Economics Of Cogeneration:

Cogeneration application in various industries like cement, sugar mill, paper mill etc. Sizing of waste heat boilers-performance calculations, part load characteristics, selection of co-generational technologies-financial considerations- operating and investments-costs of co-generation.

Unit–III Waste Heat Recovery

Introduction-principles of thermodynamics and second law- sources of waste heat recovery-diesel engines and power plant.

Unit–IV Waste Heat Recovery Systems

Recuperators, regenerators, economizers plate heat exchangers. Waste heat boilers-classification, location, service conditions and design considerations. Unfired combined cycle, supplementary fired combined cycle, fired combined cycle.

Unit–– V Applications And Techno Economics

Applications in industries-fluidized bed heat exchangers, heat pipe exchangers-heat pumps and thermic fluid heaters. Selection of waste heat recovery technologies-financial considerations, operations and investment costs of waste heat recovery.

TEXT BOOKS

1. Charles H Butler, “Co-generation”, Mc Graw Hill, New York,1984.
2. Horlock J H, “Co-generation-Heat and Power, Thermodynamics and Economics”, Oxford, UK, 1987.
3. “Institute of Fuel, London, Waste Recovery”, Chapman and Hall Publishers, London,UK, 1963.
4. Sengupta Subrata, Lee SS EDS, “Waste Heat Utilization and Management”, Washington,USA,1983.

REFERENCES

1. Robert Noyes, “Cogeneration of Steam and Electric Power, Energy Technology Review”, Vol:29, Noyes Data corporation, 1978.
2. Stecher P G “Industrial and Institutional Waste Heat Recovery Energy, Technology Review”, No:37, Noyes Data Corporation 1978.

COURSE OUTCOMES

Upon completion of the course, students will be able to

1. Learn the significance of co-generation
2. Understand the economics of co generation
3. Learn the thermodynamics of waste recovery
4. Learn the various systems used for waste heat recovery
5. Familiar with the economics of waste heat recovery

MEOESCN	MAINTANANCE AND SAFETY ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives

- To develop your ability in formulating suitable maintenance strategies to achieve reliable a manufacturing system and achieve continuous system availability for production.
- To equip you with essential system diagnosis techniques so that you can identify and take appropriate actions on error symptoms and causes of failures.
- Apply safe working practices and understand the principles of preventive and first-line maintenance.
- Understand the principles of power transmission systems; remove and refit bearings, keyed shafts, belts & chains; install & align shafts; tension drive train components and to empower you with the skills to manage manufacturing system and man safely.

Unit–I Need for Maintenance - Types of maintenance - Maintenance organisation charts for large, medium and small size plants - Basic functions of maintenances. Preventive maintenance - Need for preventive maintenance - Starting of preventive maintenance programme - Equipment record - Check list - Inspection - What to inspect - Frequency of inspection aids to good preventive maintenance.

Unit–II Maintenance of Ball, Roller and Tapered Bearing - Maintenance of Belt, Chain, Gears, Pulleys, Shafting and Fasteners.

Unit–III Maintenance of cranes - Hooks and slings - Industrial trucks - Maintenance of Power Plant Equipments - Centrifugal pumps, fans & blowers. Maintenance of Mining Equipments- Bucket Wheel excavator.

Unit–IV Devices for safeguarding machines - points to be considered in designing the guards - Enclosures, covers and barricades - Safeguarding of fast and loose pulleys, chain and rope drives,

revolving machines, pressure plates and self acting machines - Remote tripping and starting devices.

Unit–V Safety Engineering - Accident Prevention - Various steps to accomplish accident prevention - Safety measures and safety precaution in workshops - Protection of eyes - Protection against dangerous fumes - Protection against fire - Wage incentive to satisfy workman compensation.

TEXT BOOKS

1. Morrow, Industrial Maintenance
2. Charles D Reese, Occupational Health & Safety Management, CRC Press.

REFERENCES

1. Rolland P. Blake - Industrial Safety, Prentice Hall of India Pvt. Ltd.
2. Mayard, Industrial Engineering.
3. Agarwal, Machine Building Technology.
4. Keith Mobley, Maintenance Engineering Handbook, McGraw-Hill Companies Inc.
5. Keith Mobley, Maintenance Fundamentals, Elsevier Butterworth-Heinemann.

COURSE OUTCOMES

Upon completion of the course, students will be able to

1. Understand the various types of maintenance
2. Understand the relationship of key concepts in reliability engineering and application to maintenance strategies in a manufacturing environment.
3. Learn the maintenance technique for mining equipments
4. Establish maintenance strategies according to system characteristics and design transition programs to implement these strategies.
5. Manage the manufacturing organization with highest possible availability with safety.

MEOESCN	ENGINE POLLUTION AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To create awareness on air pollution due to I.C. engines and its effects on human health.
- To study the different emission formation mechanism of engines.
- To study the methods of reducing or eliminating the harmful gases from engine.
- To study the different norms and legislations to put a check over the air pollution.

Unit–I Atmospheric pollution from internal combustion engines– Global warming – Green house effect- Sources of automotive pollution – effects of pollutions on health and environment – fuels – types of hydrocarbons-properties of fuels and testing, fuel additives.

Unit–II Pollution formation mechanism- SI and CI engine– oxides of nitrogen, Zeldovich mechanism, carbon monoxide, hydrocarbon formation and different types of smoke, smog, particulate emission, soot formation.

Unit–III Evaporative emission control – PCV – crank case emission – Air fuel mixture – hot, cold and internal EGR - air injection – thermal reactor –water injection- in cylinder control of pollution – catalytic converters – selective catalyst reduction(SCR) – DeNOx catalyst- application of micro processor in emission control.

Unit–IV Emission measurements-Non dispersive infrared gas analyser, gas chromatography, Chemiluminescent analyser and flame ionisation detector – smoke measurement – Particulate measurement – high volume sampler – micro dilution tunnel –noise measurement and control.

Unit–V Fuel modification-GDI, HCCI and CRDI-driving cycles for emission measurement – chassis dynamometer – constant volume sampling (CVS) system –National and international emission norms, driving cycles.

TEXT BOOKS

1. John B. Heywood, Internal combustion engines, McGraw Hill.
2. Crouse William, Automotive emission control, Gregg Division, McGraw Hill, 1971.

REFERENCES

1. George, Springer and Donald J. Patterson, Engine emissions, pollutant formation and Measurement, Plenum press, 1973.
2. Obert, E.F., Internal Combustion engines and air pollution, Intext Educational Publishers, 1980.
3. Pundir, B.P., Engine Emissions, Narosa Publishing House, 2007.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

1. Learn the sources of pollution from IC engines
2. Understand the various types of engine pollution.
3. Learn the various mechanisms of emission control.
4. Know the various emission measuring equipments.
5. Acquire the knowledge of emission standards and fuel modification in engines.

HONOURS ELECTIVE COURSES

MEHE SCN	COMPUTATIONAL HEAT TRANSFER	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To impart fundamental mathematical concepts related to computational heat transfer.
- To impart fundamental mathematical concepts about fluid flow and heat transfer.
- To train students in the usage of computational codes and develop new ones.

Unit-I

Mathematical Description of Physical Phenomena Governing Differential Equation - Energy Equation - Momentum Equation - Nature of Co-ordinates - Discretization Methods Finite Difference Methods in Partial Differential Equations Parabolic Equations - Explicit, Implicit and Crank Nicholson Methods. Finite Differences in Cartesian and Polar Co-ordinates. Local Truncation Error - Consistency Convergence - Stability - ADI Methods. Elliptic Equations - Laplace's Equation. Laplace's Equation in a Square - Non-rectangular Regions - Mixed Boundary Condition - Jacobi - Gauss- Siedel and SOR Methods. Necessary and Sufficient Conditions for Iterative Methods Finite Difference

Unit-II Applications in Heat Condition and Convection

Control Volume Approach - Steady and Unsteady One Dimensional Conduction - Two and Three Dimensional Situations - Solution Methodology.

Unit-III Convection and Diffusion

Upwind Scheme - Exponential Scheme. Hybrid Scheme - Power Law Scheme : Calculation of the Flow Field - Simpler Algorithm.

Unit-IV Finite Element Method Concept

General Applicability of the Method using one dimensional heat transfer equation - Approximate Analytical Solution - Raleigh's Method. Galerikin Method, Solution Methods. Finite Element Method Packages - General Procedure - Discretisation of the domain - Interpolation Polynomials -

Unit-V

Formulation of Element Characteristic Matrices and Vectors - Direct, Variational and Weighted - Residual Approach - Higher Order Isoparametric Element Formulations Conduction and Diffusion Equations - Heat Transfer Packages - Heat 2, HEATAX, RADIAT, ANSYS.

TEXT BOOKS

1. Subash V.Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, 1980
2. Jaluria and Torrance, Computational Heat Transfer - Faluria and Torrance, Hemisphere Publishing Corporation, 1986.

REFERENCES

1. Mitchell A.R and Grifths D.F., Finite Difference Method in Partial Differential Equations, John Wiley & Sons, 1980.
2. Rao S.S., The Finite Element Methode in Engineering, Pergamon Press – 1989.
3. Zienkiewicz O.C. and Taylor R.L., The Finite Element Method IV Edition - Vol. I & II, McGraw Hill International Edition, 1991

MEHE SCN	STEAM ENGINEERING	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES

- To impart the basics of steam engineering
- To impart knowledge on various boiler codes
- To study the methods to analyse the boiler performance

Unit-I: Introduction-Fundamentals of steam generation, Quality of steam, Use of steam table, Mollier Chart Boilers ,Types, Mountings and Accessories, Combustion in boilers, Determination of adiabatic flame temperature, quantity of flue gases, Feed Water and its quality, Blowdown; IBR, Boiler standards

Unit-II Piping & Insulation-Water Line, Steam line design and insulation; Insulation-types and application, Economic thickness of insulation, Heat savings and application criteria, Refractory-types, selection and application of refractory, Heat loss.

Unit-III: Steam Systems Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Steam Engineering Practices; Steam Based Equipments / Systems.

Unit-IV: Boiler Performance Assessment-Performance Test codes and procedure, Boiler Efficiency, Analysis of losses; performance evaluation of accessories; factors affecting boiler performance.

Unit-V: Energy Conservation and Waste Minimization- Energy conservation options in Boiler; waste minimization, methodology; economical viability of waste minimization - Instrumentation & Control Process instrumentation; control and monitoring. Flow, pressure and temperature measuring and controlling instruments, its selection

TEXT BOOKS:

1. T. D. Estop, A. McConkey, Applied Thermodynamics, Parson Publication
2. Domkundwar; A Course in Power Plant Engineering; Dhanapat Rai and Sons.

REFERENCES:

1. Yunus A. Cengel and Boles, “Engineering Thermodynamics “,Tata McGraw-Hill Publishing Co. Ltd
2. Book II - Energy Efficiency in Thermal Utilities; Bureau of Energy Efficiency
3. Book IV - Energy Performance Assessment for Equipment & Utility Systems; Bureau of Energy Efficiency Edited by J. B. Kitto & S C Stultz; Steam: Its Generation and Use; The Babcock and Wilcox Company
4. P. Chatopadhyay; Boiler Operation Engineering: Questions and Answers; Tata McGrawHill Education Pvt Ltd, N Delhi

MEHE SCN	ADVANCED ENGINES AND EMISSION SYSTEMS	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES

- To explore recent trends, combustion modes and add on devices of automotive engines persisting in transportation system
- To reveal formation of pollution strategies of emission and control in in-cylinder combustion and after burn conditions.
- To understand measurement of exhaust emission using chassis dynamometer and trends in vehicle emission standards.

Unit-I Advanced Engines

Advanced combustion modes – Gasoline Direct Injection (GDI) engine – stratified and homogeneous charge mode - ignition technology – plasma ignition – Common Rail Diesel Injection (CRDI) system – high pressure injection - Homogeneous Charge Compression Ignition (HCCI) engine - hybrid electric vehicles – fuel cells **–** add on devices - variable valve timing (VVT) – VTEC - downsizing and turbo charging

Unit-II SI and CI Engine Combustion

Features of SI engine combustion processes - combustion process characterization – pre ignition and knocking- Thermodynamic analysis of burned and unburned mixture states - Combustion variations - factors affecting combustion - effect on performance and emissions -
Features of CI engine combustion process - combustion process characterization - Ignition delay and factors affecting delay - air motion - Mixing controlled combustion and heat release rates - effect of engine design variables - - Thermodynamic analysis of CI engine combustion

Unit-III Pollutant Formation

Pollutant formation in SI Engine - Unburned HC formation - HC oxidation in the cylinder and exhaust - exodus of HC contribution of different sources - Flame quenching in SI engines kinetics of NO and NO2 formation – CO and CO_2 – Pollutant formation in CI Engines Formation of HC in CI engines – effect of nozzle design and other variable - NO and NO2 formation in premixed and diffusion combustion periods. Formation of CO and kinetic effects - effect of engine variables - Composition of particulates - soot formation - soot structure - stoichiometric considerations, nucleation, growth and oxidation

Unit-IV Emission Control Systems

Strategies for emission control - emissions control inside the engine - EGR, crankcase and evaporative emission control - Exhaust gas after treatment - thermal and catalytic reactors - elements of reactors, catalysts and substrates – oxidation and reduction – Three way catalytic reactors - closed loop feedback control - catalyst deactivation mechanism - cold start HC control - Lean de-NOx catalysts - NOx traps and SCR- Diesel particulate filters (DPF) - DPF regeneration

Unit-V Measurement of Emissions

Measurement of emissions - instrumentation for CO, HC, NOx, PM and smoke emissions - chassis dynamometer – isokinetic sampling - constant volume sampling (CVS) system – development of driving cycles – driving cycle tests procedures – European, US and Japan driving cycles - trends in vehicle emission standards - emission limits - national and international emission norms

TEXT BOOKS

1. J.B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill International Editions, 1989.
2. B. P. Pundir, Engine Emissions: Pollutant Formation and Advances in Control Technology, Narosa Publishing House, New Delhi, 2007.

REFERENCES

1. Handbook of Air Pollution from Internal Combustion Engines: Pollutant Formation and Control, Ed. Eran Sher, Academic Press, 1998.
2. V Ganesan, Internal Combustion Engines (Fourth Edition)Tata McGraw-Hill Education Pvt. Ltd, 2013

MEHE SCN	ENERGY AUDITING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- Familiarizing with management, especially with management in energy sector engineering.
- Fundamentals of product strategy management. Studying methods of energy accounting and energy auditing in energy sector, industry and final consumption.
- Finding opportunities to increase the rational use of energy.

Unit-I Introduction: Energy Scenario - Principles and Imperatives of Energy Conservation – Energy Consumption Pattern - Resource Availability - Role of Energy Managers in Industries

Unit-II: Thermal Energy Auditing: Energy Audit - Purpose, Methodology with respect to Process Industries -Power Plants, Boilers etc. - Characteristic Method Employed in Certain Energy Intensive Industries - Various Energy Conservation Measures in Steam System - Losses in Boiler, Methodology of Upgrading Boiler Performance. Energy Conservation in Pumps, Fans & Compressors, Air conditioning and refrigeration systems, Steam Traps - Types, Function, Necessity

Unit-III: Role of Instrumentation in Energy Conservation: Total Energy Systems - Concept of Total Energy -Advantages & Limitations - Total Energy System & Application - Various Possible Schemes Employing Steam Turbines Movers Used in Total Energy Systems - Potential & Economics of Total Energy Systems

Unit-IV :Electrical Energy Auditing: Potential Areas for Electrical Energy Conservation in Various Industries - Energy Management Opportunities in Electrical Heating, Lighting System, Cable Selection - Energy Efficient Motors - Factors Involved in Determination of Motor Efficiency- Adjustable AC Drives, Application & its use Variable Speed Drives Belt Drives

Unit-V: Energy Management: Importance of Energy Management, Energy Economics - Discount Rate, Payback Period, Internal Rate of Return, Life Cycle Costing (5)

TEXT BOOKS

1. CB Smith, Energy Management Principles, Pergamon Press, New York, 1981
2. Hamies, Energy Auditing and Conservation ; Methods, Measurements, Management & Case Study, Hemisphere, Washington, 1980

REFERENCES

1. Trivedi, PR, Jolka KR, Energy Management, Commonwealth Publication, New Delhi, 1997
2. Witte, Larry C, Industrial Energy Management & Utilization, Hemisphere Publishers, Washington, 1988
3. Diamant, RME, Total Energy, Pergamon, Oxford, 1970

MEHE SCN	MECHANICAL VIBRATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- This course introduces to the students the different types of vibrations,
- To learn the causes of vibrations and means of damping it out.

Unit-I Single Degree Freedom:
Damped, Free Vibrations systems – effects of viscous damping – Logarithmic decrement – Coulomb damping.

Unit-II Forced Vibration - constant harmonic excitation – effect of rotating and reciprocating unbalance – Vibration isolation and transmissibility – vibration measuring instruments.

Unit-III Two degree of Freedom Systems:
Principal modes of Vibration -spring mass system. -Double pendulum two rotor system – Vibration of geared systems –combined rectilinear and angular modes-undamped dynamic vibration absorber.

Unit-IV Multi degree freedom systems – influence numbers and Maxwell's reciprocal theorem– Matrix method - stiffness matrix, dynamic matrix– Natural frequencies and principal modes by matrix iteration.

Unit-V Numerical methods for finding natural frequency – Far coupled systems –Rayleigh's approach–Dunkerley's method – Introduction to Finite element method – Standard Eigen value problem –Non standard Eigen value problems – Finite element formulation.

TEXT BOOKS

1. Grover G.K. Mechanical Vibrations, Nemchand & Bros., Roorkee, 1993.
2. V. Ramamurthi, Mechanical Vibration Practice With Basic Theory- Narosa Publishing house, 2000

REFERENCES

1. TSE S. Morse Ivan & Hinkle T., Mechanical Vibrations, PHI
2. Den Hartog, Mechanical Vibrations American Book Co. London
3. William T. Thomson & Marie Dillon Dahleh, Theory of Vibration with Applications, Fifth Edition, 1998
4. Rao S.S. Mechanical Vibrations, Third Edition, Addison Wesley Publishing Company, NewYork, 1995.

MEHE SCN	ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To impart knowledge in Robot Kinematics and Programming
- To learn Robot safety issues and economics.

UNIT-I Fundamentals of Robot

Robot - Definition - Robot Anatomy - Co ordinate Systems, Work Envelope Types and Classification- Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load- Robot Parts and their Functions-Need for Robots-Different Applications.

UNIT-II Robot Drive Systems and End Effectors

Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, 90 Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

UNIT-III Sensors and Machine Vision

Requirements of a sensor, Principles and Applications of the following types of sensors- Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors ,binary Sensors., Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors, Camera, Frame Grabber, Sensing and Digitizing Image Data-Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, ApplicationsInspection, Identification, Visual Serving and Navigation.

UNIT-IV Robot Kinematics and Robot Programming

Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces-Manipulator Dynamics, Trajectory Generator, Manipulator Mechanism Design-Derivations and problems. Lead through Programming, Robot programming Languages-VAL Programming-Motion Commands, Sensor Commands, End Effector commands and simple Programs.

UNIT-V Implementation and Robot Economics

RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots. PERIODS Upon completion of this course, the students can able to apply the basic engineering

TEXT BOOKS

1. Klafter R.D., Chmielewski T.A and Negin M., “Robotic Engineering - An Integrated Approach”, Prentice Hall, 2003.
2. Groover M.P., “Industrial Robotics -Technology Programming and Applications”, McGraw Hill, 2001.

REFERENCES

1. Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, 2008.
2. Deb S.R., “Robotics Technology and Flexible Automation” Tata McGraw Hill Book Co., 1994.
3. Koren Y., “Robotics for Engineers", Mc Graw Hill Book Co., 1992.
4. Fu.K.S.,Gonzalz R.C. and Lee C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill Book Co., 1987.
5. Janakiraman P.A., “Robotics and Image Processing”, Tata McGraw Hill, 1995. 6. Rajput R.K., “Robotics and Industrial Automation”, S.Chand and Company, 2008.
6. Surender Kumar, “Industrial Robots and Computer Integrated Manufacturing”, Oxford and IBH Publishing Co. Pvt. Ltd., 1991.

MINOR ELECTIVES COURSES

MEMI SCN	BASIC THERMAL ENGINEERING	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES

To make the student understand the basic concepts and applications of the following. Basics and fundamental laws of Thermodynamics.

- Properties of steam
- Internal combustion engines.
- Heat transfer, refrigeration and air conditioning.
- Metrology and mechanical measurements.

Unit–I: Thermodynamics Basic concepts of thermodynamics - System properties, state and equilibrium - Process and cycle - Work - Heat and other forms of energy - Zeroth law and application - First law - Statements - Applications to closed and open systems - General energy equation and application - Second law - Statements - Reversibility, Carnot cycle and theorems - Clausius inequality - Concept of entropy - Availability and irreversibility.

Unit–II : Properties of Steam Properties of steam - Use of steam tables - Mollier chart - Rankine cycle - Representation on P-V and T-S diagrams - Reheat cycles - calculation of efficiencies. Steam turbines - Impulse and reaction type - Governing of steam turbines - Types - Condensers.

Unit–III : Internal Combustion Engines Internal combustion engine - Principle of operation - Two stroke and four stroke cycle engines - Petrol and diesel engines - Conventional and electronic fuel injection systems - Cooling and lubrication methods - Testing of 1C engines - Simple problems - Air standard cycles - Otto, Diesel and dual cycle - Efficiencies - Simple problems.

Unit–IV : Refrigeration - Units of refrigeration - Refrigerants and their properties - Types of refrigeration system - Air, vapour compression and vapour absorption systems - simple problems in Air and Vapour compression only – Psychometric and Psychometric processes. Air conditioning - Summer and winter air conditioning.

Unit–V : Metrology and Mechanical Measurements Measurement and precision engineering: Linear and angular measurement - Measurement of flatness, stiffness and hardness. Comparators, side bands, slip gauges, angular gauges and auto collimeter. Measurement of pressure Mcleod vaccum gauge and electrical resistance pressure gauges - Dynamic characteristics of pressure measuring systems. Measurement of temperature Bimetallic thermometers - Linear quartz thermometer and pyrometers. Measurement of strain: Electrical resistance strain gauge, constant current strain gauge and strain gauge bridge circuit.)

TEXT BOOKS

1. Nag P.K, Engineering Thermodynamics,Fifth Edition, Tata Mc Graw Hill Publishing Company Limited, New Delhi, 1991.
2. Ballaney P.L , Thermal Engineering, Khanna Publishers, Delhi, 1991

REFERENCES

1. Domkundwar S, A Course in Thermodynamics and Heat Engines, Dhanpat Rai and Sons, New Delhi, 1989.
2. Mathur M.L and Sharma R.P, Internal Combustion Engines, Dhanpat Rai & Sons, New Delhi, 1992.
3. Saravanan C.G &. Ashok M.P, Thermodynamics, Scitech Publications, 2008.
4. Arora C.P, Refrigeration and Airconditioning, Tata Mc Graw Hill Publishing Company Limited, New Delhi, 1993.
5. Thomas G. Beckwith and Lewis Buck.N, Mechanical Measurements, Narosa Publishing Company. New Delhi, 1992.

MEMI SCN	INSTRUMENTATION AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To provide a basic knowledge about measurement systems and their components
- To learn about various sensors used for measurement of mechanical quantities
- To learn about system stability and control
- To integrate the measurement systems with the process for process monitoring and control

Unit–I Generalised measurement system - Basic standards of measurement - Errors - Classification. Measurements of displacement, force and torque. Dynamometers: Hydraulic, Absorption and Eddy current.

Unit–II Measurement of strain - Bonded and unbounded strain gauges - Requirements of materials. Mechanical - Electrical - Opto mechanical strain gauges. Measurement of temperature - electrical and non-electrical methods - Bimetallic and pressure thermometer, thermocouples - requirements - Resistance thermometers - Pyrometry - Calibration methods.

Unit–III Measurements of Pressure and flow - Measurements of high pressure and low pressure - Measurements of flow by obstruction meters - Velocity probes - Hot wire anemometer - Calibration of pressure gauges and flow meters - Time constant of pressure gauges.

Unit–IV Elementary ideas of automatic control - Open and closed systems, on-off, proportional, and floating modes, reset and rate actions. Basic combined modes for pneumatic, hydraulic and electrical systems.

Unit–V Transfer function - Stability - Routh's criterion - Analysis of second order systems – System response to step – step, pulse - ramp inputs. Introduction to computerized measurement and control systems (Description only)

TEXT BOOKS

1. Hollman, J.P., Experimental Methods for Engineers, Tata McGraw Hill.
2. Benjamin Kuo, Automotive Control Engineering, EEE Publications.

REFERENCES

3. D.S. Kumar, 'Mechanical Measurement & Control', Metropolitan Book Company.
4. Beckwith, T.C & Buck, N.L., Mechanical Measurements, Addison Wesley.
5. Nagarth and Gopal, Control Engineering, Wiley Eastern Ltd.
6. Control System by Nagoor Kani, RBA Publications.
7. Erenest O. Doebeling, 'Measurement Systems', McGraw Hill.
8. Instrumentation and control systems by W. Bolton, 2nd edition, Newnes,
9. Thomas G. Beckwith, Roy D. Marangoni, John H. LienhardV , Mechanical Measurements (6^{th} Edition) 6th Edition, Pearson Education India, 2007
10. Gregory K. McMillan, Process/Industrial Instruments and Controls Handbook, Fifth Edition, McGraw-Hill: New York,1999.

MEMI SCN	ELEMENTS OF HEAT TRANSFER	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES

- The aim of the course is to build a solid foundation in heat transfer exposing students to the three basic modes namely conduction, convection and radiation.
- Rigorous treatment of governing equations and solution procedures for the three modes will be provided, along with solution of practical problems using empirical correlations.
- The course will also briefly cover boiling and condensation heat transfer, and the analysis and design of heat exchangers.

Unit-I: Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, Composite Medium, critical insulation thickness. Extended surfaces

Unit-II: Lumped system approximation and Biot number, Two dimensional conduction solutions for both steady and unsteady heat transfer-approximate solution to unsteady conduction heat transfer by the use of Heissler charts.

Unit-III: Heat convection, basic equations, boundary layers- Forced convection, external and internal flows-Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection- Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow-Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.

Unit-IV: Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method. Radiation Shields

Unit-V: Types of heat exchangers, Analysis and design of heat exchangers using both LMTD and ε-NTU methods. Boiling and Condensation heat transfer, Pool boiling curve. Introduction mass transfer, Similarity between heat and mass transfer.

TEXT BOOKS

1. Yunus A Cengel, Heat Transfer : A Practical Approach, McGraw Hill, 2002
2. J.P.Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.

REFERENCES

1. F.P.Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley, Sixth Edition, 2007.
2. MassoudKaviany, Principles of Heat Transfer, John Wiley, 2002
3. A.Bejan, Heat Transfer John Wiley, 1993

MEMI SCN	ELEMENTS OF MACHINE DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

Unit–I Introduction: Types of Design factors. Factor of safety, Theories of failure - Curved beam, crane hook and C frames. Design for fatigue strength: S-N diagram - Endurance limit modifying factors - Stress concentration - Fluctuation stress – Soderberg & Good Man equations.

Unit–II Thin cylinders – Stresses in thin cylindrical shell due to internal pressure – circumferential and longitudinal stresses and deformation in thin cylinders Design of mechanical elements: Shafts – Design for static load – bending and torsion – 79 Equivalent twisting moment. Coupling - Types - Design and selection of coupling - Flange coupling, Bushed pin type, flexible coupling design and selection.

Unit–III Theory of columns: Design of push rod, piston rod and I.C. Engine connecting rods sections. Wire ropes - Stresses - selection Design procedure–leaf springs - construction equalized stresses in leaves - material and design. Open and closed coiled helical springs stress - Wahl's factor.

Unit–IV Power screws - Thread forms Design consideration and materials - wear and shear - design procedure. Threaded fasteners – Bolted joints – simple and eccentrically loaded bolted joints.

Unit-V Design of Joints: Riveted Joints: Introduction - Types of riveted joints - failures of a riveted joint - strength and efficiency - Design of boiler joints. Welded joints: Introduction - Strength of transverse and parallel fillet welded joints - Axially loaded unsymmetrical welded sections - Eccentrically loaded welded joints.

TEXT BOOKS

1. Khurmi, R.S., “Machine Design”, S. Chand and Company Ltd., New Delhi, 14th edition, 2005.
2. Pandya, and Sha., “Machine Design”, Charotar Publisher, house, Anand, India

REFERENCES

1. Richard Budynnas, J.E. Shigley’s, “Mechanical Engineering Design”, McGraw Hill Book Company, 8th ed., 2008.
2. Prabhu, T.J., “Fundamentals of Machine Design”, Scitect Publisher 4th edition, 2000.
3. Sundararajamoorthy, T.V., and N. Shanmugam, “Machine Design”, Anuradha Agencies, 2000.

MEMI SCN	POWER PLANT TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To provide an overview of power plants and the associated energy conversion issues

Unit-I Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers, steam and heating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems

Unit-II Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems.

Unit-III Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants.

Unit-IV Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems

Unit-V Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants.

TEXT BOOKS

1. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2008.
2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.

REFERENCES

1. Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.

COURSE OUTCOMES

Upon completion of the course, the students will be able to

1. Understand the principles of operation of coal based power plant
2. Learn the working of gas power plants
3. Basics of nuclear reactors
4. Understand various non conventional power plants
5. Gain knowledge on power plant economics.

MEMI SCN	AUTOMOBILE TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart the knowledge about the engine chassis, transmission, steering, suspension systems, rear axles and final drive of Automobiles.
- To Study the concept of electrical system, sensors and fuel injection system in automobiles

UNIT I

Engine chassis frame – layout of chassis and its main components – functions of the chassis frame – types – laden – monocoque – various loads acting on the chassis frame. The Clutch - Function- Single plate, multi plate clutches - Torque converters.

UNIT II

Gear Boxes - Function – Sliding mesh - Constant mesh and synchromesh gear boxes - Selector Mechanism – Working of Automatic gear boxes - over drive - Front wheel drive - Propeller shaft and universal joints - Constant velocity Universal joints.

UNIT III

Front axle and steering geometry - Principle of power steering - steering mechanism – Re-circulating ball mechanism - cam & double pin steering gear boxes - Camber angle, Caster angle, King pin inclination - Types of frames and suspension systems. Independent suspension - Rear suspension - Pneumatic suspension.

UNIT IV

Rear axle - final drive - Single and double reduction axle, torque and thrust members - arrangements. Differential - function of differential - differential lock - rear axle-housing construction - Rear axle arrangements. Brakes - Mechanical, disc, hydraulic and pneumatic brakes - servo brakes – antilock braking systems.

UNIT V

Electrical system of the automobile - Battery – Ignition system - Gasoline injection- throttle body injection and multi point fuel injection systems- controls -– CRDI system for diesel engine. Engine sensors - types– oxygen sensors, crank angle position sensors – fuel metering, vehicle speed sensors - detonation sensor – altitude sensor, flow sensor, throttle position sensors, relays. GPS navigation system.

TEXT BOOKS

1. William H. Crouse and Donald L. Anglin, “Automotive Mechanics”, Tata McGraw Hill, 2004, Tenth Edition.
2. Gupta R.B., Automobile Engineering, Sathya Prakasam New Market, New Rohta road, New Delhi.

REFERENCE BOOKS

1. Mangal M.K., Diesel Mechanics, Tata McGraw Hill.
2. Crouse William, Automotive Emission control, Gregg Division McGraw-Hill.
3. Bosch “Automotive Handbook”, Robert Bosch GmbH, Germany, 2004, Sixth Edition.
4. John.B.Heywood, Internal Combustion Engines, McGraw-Hill.
5. Newton & Steeds, Motor Vehicles.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

1. Identify the different systems in an automobile
2. Understand different auxiliary, sensors, fuel injection and transmission systems in automobiles.