B.E.- MECHANICAL ENGINEERING

CURRICULUM AND SYLLABUS FOR CHOICE BASED CREDIT SYSTEM

DEPARTMENT OF MECHANICAL ENGINEERING

MAHENDRA INSTITUTE OF TECHNOLOGY
(AUTONOMOUS)

(Accredited by NAAC with 'A' grade, Approved by AICTE &
Affiliated to Anna University, Chennai)
Mallasamudram - 637 503

Regulation -2020

MAHENDRA INSTITUTE OF TECHNOLOGY

(Accredited by NAAC with 'A' grade , Approved by AICTE & Affiliated to Anna University, Chennai)
Mallasamudram - 637 503

Department: **Mechanical Engineering**

Programme: **B.E**

Semester-I

Sl. No	Category	Course Code	Course Title	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
1	MC	MC2067001	Induction program (3 weeks)	-	-	-	-	-	-	-
THEORY										
1	HS	EN2011101	Communicative English	3	0	0	3	50	50	100
2	BS	MA2012101	Matrices and Calculus	3	1	0	4	50	50	100
3	BS	PH2012101	Engineering Physics	3	0	0	3	50	50	100
4	BS	CY2012101	Engineering Chemistry-I	3	0	0	3	50	50	100
5	ES	GE2013101	Basic Electrical and Electronics Engineering	3	0	0	3	50	50	100
6	ES	GE2013102	Engineering Drawing	1	0	4	3	50	50	100
PRACTICAL										
7	BS	GE2022101	Physics and Chemistry Laboratory	0	0	4	2	50	50	100
8	ES	GE2022001	Engineering Practices Laboratory	0	0	4	2	50	50	100
			Total credits for semester I				**23**			

Semester II

Sl. No	Category	Course Code	Course Title	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
THEORY										
1	HS	EN2011201	Technical English	3	0	0	3	50	50	100
2	BS	MA2012201	Vector Calculus and Complex Variables	3	1	0	4	50	50	100
3	BS	PH2012202	Materials Science	3	0	0	3	50	50	100
4	BS	CY2012201	Engineering Chemistry- II	3	0	0	3	50	50	100
5	ES	ME2013201	Engineering Mechanics	3	0	0	3	50	50	100
6	ES	CS2013201	Programming with Python	3	0	0	3	50	50	100
PRACTICALS										
7	HS	GE2021201	Communication and Soft skills Laboratory	0	0	2	1	50	50	100
8	ES	CS2023201	Python Programming Laboratory	0	0	4	2	50	50	100
9	MC	MC2067006	Social Media as an Educational Tool	-	-	-	-	100	-	100
			Total credits for semester II				**22**			

Semester			III								
Sl. No	Category	Course Code	Course Title	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
THEORY											
1	BS	MA2012301	Transforms and Partial Differential Equations	2	1	0	3	50	50	100
2	PC	ME2014301	Engineering Thermodynamics	3	0	0	3	50	50	100
3	PC	ME2014302	Kinematics of Machinery	3	0	0	3	50	50	100
4	PC	ME2014303	Manufacturing Technology -I	3	0	0	3	50	50	100
5	ES	EE2013301	Electrical Drives and Controls	3	0	0	3	50	50	100
6	MC	MC2067005	Environmental Science and Engineering	-	-	-	-	100	-	100
7	MC	MC2067003	Introduction to Biology	-	-	-	-	100	-	100
PRACTICALS										
8	PC	ME2024301	Manufacturing Technology Laboratory–I	0	0	4	2	50	50	100
9	PC	ME2024302	Computer Aided Machine Drawing	0	0	4	2	50	50	100
10.	ES	EE2023301	Electrical Engineering Laboratory	0	0	4	2	50	50	100
Total credits							**21**			

Semester			IV								
Sl. No	Category	Course Code	Course Title	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
THEORY											
1	BS	MA2012403	Statistics and Numerical Methods	2	1	0	3	50	50	100
2	ES	ME2014401	Fluid Mechanics and Machinery	3	0	0	3	50	50	100
3	ES	ME2014402	Strength of Materials	3	0	0	3	50	50	100
4	PC	ME2014403	Manufacturing Technology –II	3	0	0	3	50	50	100
5	PC	ME2014404	Thermal Engineering-I	2	1	0	3	50	50	100
6	MC	MC2067002	Universal Human Values	2	1	0	3	50	50	100
PRACTICALS										
7	PC	ME2024401	Manufacturing Technology Laboratory– II	0	0	4	2	50	50	100
8	ES	ME2024402	Strength of Materials and Fluid Mechanics and Machinery Laboratory	0	0	4	2	50	50	100
9	ES	ME2024403	Thermal Engineering Laboratory	0	0	4	2	50	50	100
10	EEC	ME2076401	In plant Training	0	0	0	1	100		100
Total credits for semester IV							**25**			

Semester			V							
Sl. No	Category	Course Code	Course Title	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
THEORY										
1	PC	ME2014501	Heat and Mass Transfer	2	1	0	3	50	50	100
2	PC	ME2014502	Design of Machine Elements	3	0	0	3	50	50	100
3	PC	ME2014503	Metrology and Measurements	3	0	0	3	50	50	100
4	PC	ME2014504	Dynamics of Machines	3	0	0	3	50	50	100
5	OE		Open Elective I	3	0	0	3	50	50	100
PRACTICALS										
6	PC	ME2024501	Kinematics and Dynamics Laboratory	0	0	4	2	50	50	100
7	PC	ME2024502	Heat and Mass Transfer Laboratory	0	0	4	2	50	50	100
8	PC	ME2024503	Computational fluid dynamics lab	0	0	4	2	50	50	100
9	PC	ME2024504	Metrology and Measurements Laboratory	0	0	4	2	50	50	100
Total credits for semester V							**23**			

Semester			VI							
Sl. No	Category	Course Code	Course Title	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
THEORY										
1	PC	ME2014601	Design of Transmission Systems	3	0	0	3	50	50	100
2	PC	ME2014602	Computer Aided Design and Manufacturing	3	0	0	3	50	50	100
3	PC	ME2014603	ThermalEngineering-II	3	0	0	3	50	50	100
4	PC	ME2014604	Finite Element Analysis	3	0	0	3	50	50	100
5	PE		Professional Elective–I	3	0	0	3	50	50	100
PRACTICALS										
6	PC	ME2024601	CAD /CAM Laboratory	0	0	4	2	50	50	100
7	EEC	ME2024602	Design and Fabrication Project	0	0	4	2	50	50	100
8	EEC	EN2021601	Professional Communication	-	-	-	-	100	-	100
Total credits for semester VI							**19**			

Semester			VII							
Sl. No	Category	Course Code	Course Title	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
THEORY										
1	PC	ME2014701	Power Plant Engineering	3	0	0	3	50	50	100
2	PC	ME2014702	Mechatronics	3	0	0	3	50	50	100
3	PE		Professional Elective–II	3	0	0	3	50	50	100
4	PE		Professional Elective–III	3	0	0	3	50	50	100
5	MC	MC2067004	Indian Constitution	2	0	0	0	-	-	-
PRACTICALS										
6	PC	ME2024701	Simulation and Analysis Laboratory	0	0	4	2	50	50	100
7	PC	ME2024702	Mechatronics Laboratory	0	0	4	2	50	50	100
8	EEC	ME2046701	Technical Seminar	0	0	2	1	50	50	100
Total credits for semester VII							**17**			

Semester			VIII							
Sl. No	Category	Course Code	Course Title	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
THEORY										
1	OE		Open Elective–II	3	0	0	3	50	50	100
2	PE		Professional Elective–IV	3	0	0	3	50	50	100
PRACTICALS										
3	EEC	ME2036801	Project Work	0	0	24	12	50	50	100
Total credits for semester VIII							18			

Professional Electives (PE) Semester-VI Professional Elective-1											
Sl. No	Category	Course Code	Course Title	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
THEORY											
1	PE	ME2014601	Automobile Engineering	3	0	0	3	50	50	100
2	PE	ME2014602	Welding Technology	3	0	0	3	50	50	100
3	PE	ME2014603	Gas Dynamics and Jet Propulsion	3	0	0	3	50	50	100
4	PE	ME2014604	Intellectual Property Rights	3	0	0	3	50	50	100
5	PE	ME2014605	Fundamentals of Nano Science	3	0	0	3	50	50	100
6	PE	ME2014606	Principals of Management	3	0	0	3	50	50	100
7	PE	ME2014607	Disaster Management	3	0	0	3	50	50	100
8	PE	ME2014608	Hydraulics and Pneumatics	3	0	0	3	50	50	100
Semester-VII Professional Elective-II											
1	PE	ME2014701	Refrigeration and Air conditioning	3	0	0	3	50	50	100
2	PE	ME2014702	Renewable Sources of Energy	3	0	0	3	50	50	100
3	PE	ME2014703	Quality Control and Reliability Engineering	3	0	0	3	50	50	100
4	PE	ME2014704	Unconventional Machining Processes	3	0	0	3	50	50	100
5	PE	ME2014705	Operations Research	3	0	0	3	50	50	100
6	PE	ME2014706	Total Quality Management	3	0	0	3	50	50	100
7	PC	ME2014707	Process Planning and Cost Estimation	3	0	0	3	50	50	100
Semester-VII Professional Elective-III											
1	PE	ME2014708	Robotics	3	0	0	3	50	50	100
2	PE	ME2014709	Design of Jigs, Fixtures and Press Tools	3	0	0	3	50	50	100
3	PE	ME2014710	Computational Fluid Dynamics	3	0	0	3	50	50	100
4	PE	ME2014711	Non Destructive Testing and Evaluation	3	0	0	3	50	50	100
5	PE	ME2014712	Composite Materials and Mechanics	3	0	0	3	50	50	100
6	PE	ME2014713	Foundation Skills in Integrated Product Development	3	0	0	3	50	50	100
7	PE	ME2014714	Additive Manufacturing	3	0	0	3	50	50	100
Semester-VII Professional Elective-IV											
1	PE	ME2014801	Production PlanningandControl	3	0	0	3	50	50	100
2	PE	ME2014802	Entrepreneurship Development	3	0	0	3	50	50	100
3	PE	ME2014803	Computer Integrated Manufacturing Systems	3	0	0	3	50	50	100
4	PE	ME2014804	Micro Electro Mechanical Systems	3	0	0	3	50	50	100

5	PE	ME2014805	Professional Ethics in Engineering	3	0	0	3	50	50	100
6	PE	ME2014806	Human Rights	3	0	0	3	50	50	100
7	PE	ME2014807	Advanced IC Engine	3	0	0	3	50	50	100
8	PE	ME2014808	Vibration and Noise Control	3	0	0	3	50	50	100
Open Elective										
1	OE	ME2010001	Renewable Energy Sources	3	0	0	3	50	50	100
2	OE	ME2010002	Waste Management and Energy Recovery	3	0	0	3	50	50	100
3	OE	ME2010003	Fundamentals of Ergonomics	3	0	0	3	50	50	100
4	OE	ME2010004	Safety Measures for Engineers	3	0	0	3	50	50	100
5	OE	ME2010005	Electronic Engine Management	3	0	0	3	50	50	100
6	OE	ME2010006	Fundamentals of Mechanical Engineering	3	0	0	3	50	50	100
7	OE	ME2010007	Robotics	3	0	0	3	50	50	100

Mandatory Courses										
Sl. No	Category	**Course Code**	**Course Title**	**Hours / Week**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CA**	**SE**	**Tot.**
THEORY										
1	MC	MC2067001	Induction Program	-	-	-	-	100	-	100
2	MC	MC2067002	Universal Human Values	3	0	0	3	50	50	100
3	MC	MC2067003	Introduction to Biology	-	-	-	-	100	-	100
4	MC	MC2067004	Environmental Science and Engineering	-	-	-	-	100	-	100
5	MC	MC2067005	Indian Constitution	-	-	-	-	100	-	100
6	MC	MC2067006	Social Media as an Educational Tool	-	-	-	-	100	-	100

SUMMARY

S.NO.	**SUBJECT AREA**	**CREDITS AS PER SEMESTER**								**CREDITS TOTAL**
		I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	
1	HS	3	4							**7**
2	BS	12	10	3	3					**28**
3	ES	8	8	5	10					**31**
4	PC			13	8	20	14	10		**65**
5	PE						3	6	3	**12**
6	OE					3			3	**6**
7	EEC				1		2		12	**15**
8	MC				3					**3**
	Total	**23**	**22**	**21**	**25**	**23**	**19**	**16**	**18**	**167**

III Semester					
Course code	**Course Name**	**Hours/week**			**Credit**
		L	**T**	**P**	**C**
20MA12301	**Transforms and Partial Differential Equations**	2	1	0	3

Objective(s)

- To introduce Fourier series analysis, which is central to many applications in engineering apart from its use in solving boundary value problems?
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

UNIT-I	**PARTIAL DIFFERENTIAL EQUATIONS**	**12**

Formation of partial differential equations – Singular integrals -- Solutions of standard types of first order partial differential equations - Lagrange‟s linear equation -- Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT-II	**FOURIER SERIES**	**12**

Dirichlet”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 – Harmonic analysis.

UNIT-III	**APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS**	**12**

Classification of PDE – Method of separation of variables –Fourier Series Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction.

UNIT-IV	**FOURIER TRANSFORMS**	**12**

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval‟s identity.

UNIT-V	**Z - TRANSFORMS AND DIFFERENCE EQUATIONS**	**12**

Z- transforms - Elementary properties – Inverse Z - transform (using partial fraction and residues) – Initial and Final Value Theorems- Convolution theorem - Formation of difference equations – Solution of difference equations using Z - transform.

Total hours:	**60** periods

Outcome:

Upon completion of this course , students will be able to

- Understand how to solve the given standard PDE.
- Solve Differential Equations using Fourier Series Analysis which plays vital role in Engineering Application.
- Apply the transform techniques for solving ordinary differential Equations and partial differential equations.
- Understand the mathematical principles on transforms and PDE would provide them the ability to formulate and solve some of the physical problems of engineering.
- Use the effective Mathematical tools for the solution of PDE by using Z transform Techniques for discrete type systems.

TEXT BOOK :	
1	Grewal B.S., ―Higher Engineering Mathematics‖, Khanna Publishers, New Delhi, 43 Edition,2014.
2	Veerarajan T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint, 2012.
3	Narayanan S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students" Vol. II & III, S.Viswanathan Publishers Pvt Ltd. 1998.
REFERENCES:	
1	Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 7^{th} Edition, Laxmi Publications Pvt. Ltd, 2007.
2	Ramana. B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
3	Glyn James, "Advanced Modern Engineering Mathematics", 3^{rd} Edition, Pearson Education, 2007.
4	Erwin Kreyszig, "Advanced Engineering Mathematics", 8^{th} Edition, Wiley India, 2007.
5	Ray Wylie C and Barrett.L.C, "Advanced Engineering Mathematics" TataMcGraw Hill Education Pvt Ltd, Sixth Edition, New Delhi, 2012.
6	Datta K.B., "Mathematical Methods of Science and Engineering", Cengage Learning India Pvt Ltd, Delhi, 2013

III Semester					
Course code	**Course Name**	**Hours/week**			**Credit**
		L	**T**	**P**	**C**
ME2014301	**ENGINEERING THERMODYNAMICS**	3	0	0	3

Objective(s)

- To provide knowledge in the basic concepts, processes, first law and applications of thermodynamic system.
- To know about the second law, Carnot cycle and the concept of entropy.
- To familiarize the properties of pure substance and steam power cycle.
- To understand theconcepts of ideal and real gases and thermodynamics relations.
- To study the concepts of psychometric properties and processes

UNIT-I	**BASIC CONCEPT AND FIRST LAW**	**15**

Basic concepts -concept of continuum, macroscopic approach, Thermodynamic systems -closed, open and isolated. Property, state, path and process, quasi-static process, work, modes of work, Zeroth law of thermodynamics –concept of temperature and heat. Concept of ideal and real gases. First law of thermodynamics –application to closed and open systems, internal energy, specific heat capacities, enthalpy, steady flow process with reference to various thermal equipments - steady and unsteady flow processes

UNIT-II	**SECOND LAW AND AVAILABILITY ANALYSIS**	**15**

Second law of thermodynamics –Kelvin‟s and Clausius statements of second law. Reversibility and irreversibility. Carnot theorem, Carnot cycle, reversed carnot cycle, efficiency, COP. Thermodynamic temperature scale, Clausius inequality, concept of entropy, entropy of ideal gas, principle of increase of entropy –availability

UNIT-III	PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE	15

Properties of pure substances –Thermodynamic properties of pure substances in solid,liquid and vapour phases, phase rule, P-V, P-T, T-V, T-S, H-S diagrams, PVT surfaces, thermodynamic properties of steam. Calculationsof work done and heat transfer in nonflow and flow processes. Standard Rankine cycle, Reheat and regenerative cycle

UNIT-IV	IDEAL AND REAL GASES AND THERMODYNAMIC RELATIONS	15

Gas mixtures –properties ideal and real gases, equation state, Avagadro‟s Law, Vander Waal‟s equation of state, compressability factor, compressability chart –Dalton‟s law of partial pressure, exact differentials, T-D relations, Maxwell‟s relations, ClausiusClapeyron equations, Joule – Thomson coefficient.

UNIT-V	PSYCHROMETRY	15

Psychrometry and psychrometric charts, property calculations of air vapour mixtures. Psychrometric process –Sensible heat exchange processes. Latent heat exchange processes. Adiabatic mixing, evaporative cooling.

Total hours:	**75** periods

Outcome

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

- apply the first law of thermodynamics for simple open and closed systems under steady
- and unsteady conditions.
- apply second law of thermodynamics to open and closed systems and calculate entropy
- and availability.
- apply Rankine cycle to steam power plant and compare few cycle improvement methods
- derive simple thermodynamic relations of ideal and real gases
- calculate the properties of moist air and its use in psychometric processes

TEXT BOOK :

1	R.K.Rajput, “A Text Book Of Engineering Thermodynamics “,Fifth Edition,2017.
2	Yunus a. Cengel & michael a. Boles, “Thermodynamics”, 8th edition 2015.

REFERENCES:

1	Arora C.P, “Thermodynamics”, Tata McGraw-Hill, New Delhi, 2003.
2	Borgnakke & Sonnatag, “Fundamental of Thermodynamics”, 8th Edition , 2016.
3	Chattopadhyay, P, "Engineering Thermodynamics", Oxford University Press, 2016.
4	Michael J. Moran, Howard N. Shapiro, “Fundamentals of Engineering Thermodynamics”, 8th Edition.
5	Nag.P.K., “Engineering Thermodynamics”, 5th Edition, Tata McGraw-Hill, New Delhi, 2013.

Semester IV					
Course code	**Course Name**	**Hours/week**			**Credit**
		L	**T**	**P**	**C**
ME2014302	**KINEMATICS OF MACHINERY**	3	0	0	3

Objective(s)

- To understand the basic components and layout of linkages in the assembly of a system machine.
- To understand the principles in analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism.
- To understand the motion resulting from a specified set of linkages, design few linkage mechanisms and cam mechanisms for specified output motions.
- To understand the basic concepts of toothed gearing and kinematics of gear trains and the effects of friction in motion transmission and in machine components.

UNIT-I	**BASICS OF MECHANISMS**	**9**

Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, Mobility – Kutzbach criterion, Gruebler's criterion – Grashof's Law – Kinematic inversions of four-bar chain and slider crank chains –-Mechanical advantage – Transmission Angle – Description of some common mechanisms – Quick return mechanisms, Universal Joint – rocker mechanisms

UNIT-II	**KINEMATICS OF LINKAGE MECHANISMS**	**9**

Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method– Velocity and acceleration polygons – Velocity analysis using instantaneous centres – kinematic analysis of simple mechanisms – Coincident points – Coriolis component of Acceleration

UNIT-III	**KINEMATICS OF CAM MECHANISMS**	**9**

Classification of cams and followers – Terminology and definitions – Displacement diagrams – Uniform velocity, parabolic, simple harmonic and cycloidal motions – Derivatives of follower motions – Layout of plate cam profiles – Specified contour cams – Circular arc and tangent cams.

UNIT-IV	**GEARS AND GEAR TRAINS**	**9**

Law of toothed gearing – Involutes and cycloidal tooth profiles –Spur Gear terminology and definitions –Gear tooth action – contact ratio – Interference and undercutting. Helical, Bevel, Worm, Rack Gear trains – Speed ratio, train value – Parallel axis gear trains – Epicyclic Gear Trains

UNIT-IV	**FRICTION IN MACHINE ELEMENTS**	**9**

Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads – Bearings and lubrication – Friction clutches – Belt and rope drives – Friction in brakes- Band and Block brakes.

Total hours:	**45** periods

Outcome

- Discuss the basics of mechanism
- Calculate velocity and acceleration in simple mechanisms
- Develop CAM profiles
- Solve problems on gears and gear trains
- Examine friction in machine elements

TEXT BOOK :

1	F.B. Sayyad, “Kinematics of Machinery”, MacMillan Publishers Pvt Ltd., Tech-max Educational resources, 2011
2	Rattan, S.S, “Theory of Machines”, 4Edition, Tata McGraw-Hill, 2014
REFERENCES:	
1	Allen S. Hall Jr., “Kinematics and Linkage Design”, Prentice Hall, 1961
2	Cleghorn. W. L, “Mechanisms of Machines”, Oxford University Press, 2014
3	Ghosh. A and Mallick, A.K., “Theory of Mechanisms and Machines", 3rd Edition Affiliated East-West Pvt. Ltd., New Delhi, 2006.
4	John Hannah and Stephens R.C., "Mechanics of Machines", Viva Low-Prices Student Edition, 1999
5	Thomas Bevan, "Theory of Machines", 3rd Edition, CBS Publishers and Distributors, 2005.

III Semester					
Course code	**Course Name**	**Hours/week**			**Credit**
		L	**T**	**P**	**C**
ME2014303	**Manufacturing Technology – I**	3	0	0	3

Objective(s)

- To introduce the concepts of basic manufacturing processes and fabrication techniques, Such as metal casting, metal is joining, metal forming and manufacture of plastic components.

UNIT-I	**METAL CASTING PROCESSES**	**9**

Sand Casting : Sand Mould – Type of patterns - Pattern Materials – Pattern allowances- Moulding sand Properties and testing – Cores –Types and applications – Moulding machines– Types and applications; Melting furnaces : Blast and Cupola Furnaces; Principle of special casting processes : Shell - investment – Ceramic mould – Pressure die casting - Centrifugal Casting - CO2 process – Stir casting- lost foam casting – mould less casting – ice casting; Defects in Sand casting.

UNIT-II	**JOINING PROCESSES**	**9**

Operating principle, basic equipment, merits and applications of: Fusion welding processes: Gas welding - Types – Flame characteristics – filler and flux materials – types of adhesive bonding; Manual metal arc welding – Gas Tungsten arc welding - Gas metal arc welding – Submerged arc welding – Electro slag welding; Operating principle and applications of: Resistance welding - Plasma arc welding – Thermit welding – Electron beam welding – Friction welding and Friction Stir Welding; Brazing and soldering; Weld defects: types, causes and cure.

UNIT-III	**METAL FORMING PROCESSES**	**9**

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – forging operations. Rolling of metals– Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts. Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types – Hot and cold extrusion.

UNIT-IV	**SHEET METAL PROCESSES**	**9**

Sheet metal characteristics – shearing- typical shearing operation- bending and drawing operations – Stretch forming operations – Formability of sheet metal – Test methods –special forming processes- Working principle and applications – Hydro forming – Rubber pad forming – Metal spinning– Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming

UNIT-V	MANUFACTURE OF PLASTIC COMPONENTS	9

Types and characteristics of plastics – Moulding of thermoplastics – working principles and typical applications – injection moulding – Plunger and screw machines – Compression moulding, Transfer Moulding – Typical industrial applications – introduction to blow moulding –Rotational moulding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics.

Total hours: **45** periods

Outcome

- Explain different metal casting processes, associated defects, merits and demerits
- Compare different metal joining processes.
- Summarize various hot working and cold working methods of metals.
- Explain various sheet metal making processes.
- Distinguish various methods of manufacturing plastic components.

TEXT BOOK :

1	Hajra Chouldhary S.K and Hajra Choudhury. AK., "Elements of workshop Technology",volume I and II,Media promoters and Publishers Private Limited, Mumbai, 2008
2	Kalpakjian. S, “Manufacturing Engineering and Technology”, Pearson Education India Edition, 2013

REFERENCES:

1	Gowri P. Hariharan, A.Suresh Babu, "Manufacturing Technology I", Pearson Education, 2008
2	Paul Degarma E, Black J.T and Ronald A. Kosher, "Materials and Processes, in Manufacturing" Eight Edition, Prentice – Hall of India, 1997.
3	Rao, P.N. "Manufacturing Technology Foundry, Forming and Welding", 4th Edition, TMH-2013
4	Roy. A. Lindberg, "Processes and Materials of Manufacture", PHI / Pearson education, 2006
5	Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., 2014. Ltd., 2014.

SEMESTER III

Course code	Course Name	Hours/week			Credit
		L	T	P	C
EE2013301	ELECTRICAL DRIVES AND CONTROLS	3	0	0	3

OBJECTIVES:

- To understand the basic concepts of different types of electrical machines and their performance.
- To study the different methods of starting D.C motors and induction motors.
- To study the conventional and solid-state drives

UNIT-I	INTRODUCTION	9
Basic Elements – Types of Electric Drives – factors influencing the choice of electrical drives – heating and cooling curves – Loading conditions and classes of duty – Selection of power rating for drive motors with regard to thermal overloading and Load variation factors		
UNIT-II	**DRIVE MOTOR CHARACTERISTICS**	**9**
Mechanical characteristics – Speed-Torque characteristics of various types of load and drive motors – Braking of Electrical motors – DC motors: Shunt, series and compound - single phase and three phase induction motors**.**		
UNIT-III	**STARTING METHODS**	**9**
Types of D.C Motor starters – Typical control circuits for shunt and series motors – Three phase squirrel cage and slip ring induction motors.		
UNIT-IV	**CONVENTIONAL AND SOLID STATE SPEED CONTROL OF D.C. DRIVES**	**9**
Speed control of DC series and shunt motors – Armature and field control, Ward-Leonard control system - Using controlled rectifiers and DC choppers –applications.		
UNIT-V	**CONVENTIONAL AND SOLID STATE SPEED CONTROL OF A.C. DRIVES**	**9**
Speed control of three phase induction motor – Voltage control, voltage / frequency control, slip power recovery scheme – Using inverters and AC voltage regulators – applications.		
	Total hours:	**45** periods

OUTCOME:

- Upon Completion of this subject, the students can able to explain different types of electrical machines and their performance

TEXT BOOK :

1	Nagrath .I.J. & Kothari .D.P, "Electrical Machines", Tata McGraw-Hill, 2006
2	Vedam Subrahmaniam, "Electric Drives (Concepts and Applications)", Tata McGraw-Hill, 2010

REFERENCES:

1	Partab. H., "Art and Science and Utilisation of Electrical Energy", Dhanpat Rai and Sons, 2017
2	Pillai.S.K "A First Course on Electric Drives", Wiley Eastern Limited, 2012
3	Singh. M.D., K.B.Khanchandani, "Power Electronics", Tata McGraw-Hill, 2006.

III Semester					
Course code	**Course Name**	**Hours/week**			**Credit**
		L	**T**	**P**	**C**
MC2067005	**Environmental Science and Engineering**	0	0	0	0

Objective(s)

- ✓ The student expect to understand about
- ✓ To give a comprehensive insight into ecosystem, biodiversity and natural recourses.
- ✓ To create an awareness on the various environmental pollution aspects and issues.
- ✓ To educate the ways and means to protect the environment from various types of pollution.
- ✓ Discuss the impact of human population on the environment

UNIT-I	ENVIRONMENT & ECOSYSTEMS BIODIVERSITY	14

Definition, scope and importance of environment – need for public awareness – concept of an ecosystem – structure and function of an ecosystem, producers, consumers and decomposes, Food chains, Food webs. Introduction, types, characteristic features, structure and function of the terrestrial & aquatic ecosystem. Introduction to biodiversity definition: genetic, species and ecosystem diversity – Biogeographical 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– endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

UNIT-II	**ENVIRONMENTAL POLLUTION**	**7**

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (water Quality Parameter) (c) Soil pollution (d) Noise pollution (e) Marine Pollution (f) Thermal pollution– solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution- pollution case studies –disaster management: floods, earthquake, cyclones and landslides.

UNIT-III	**NATURAL RESOURCE**	**9**

Forest resources: Use and over-exploitation, deforestation, case studies.Water resources: Use and over-utilization of surface and ground water dams-benefits and problems. Food resources: Effects of modern agriculture - fertilizer - pesticide problems (Eutrophication, Blue baby Syndrome, Biomagnification) - water logging – salinity case studies. Energy resources: renewable and non renewable energy sources, use of alternate energy sources. Role of an individual in conservation of natural resources

UNIT-IV	**SOCIAL ISSUES AND THE ENVIRONMENT**	**9**

From unsustainable to sustainable development – urban problems related to energy – water conservation strategy (rain water harvesting, water shed Management) rehabilitation of people; its problems and concerns, case studies – role of nongovernmental organization- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – Wasteland reclamation – EIA and waste products – environment protection act.

UNIT-V	**HUMAN POPULATION AND THE ENVIRONMENT**	**6**

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.

Total hours:	**45** periods

Outcome(s)

At the end of the course the student will be able to

- ✓ Able to define and explain scope and importance of environment, ecosystem and biodiversity.
- ✓ Acquire knowledge about various natural resources and equitable use of resources for sustainable life style.
- ✓ Acquire knowledge on various environmental pollution and able to protect.
- ✓ Acquire knowledge on impacts of human population over the environment.

TEXT BOOK :

1	Gilbert M.Masters, "Introduction to Environmental Engineering and Science", 2nd Edition, Pearson Education, 2004.
2	Benny Joseph, "Environmental Science and Engineering", Tata McGraw-Hill, New Delhi, 2006.

3	Dr.A.Ravikrishnan, "Environmental Science and Engineering" , Sri Krishna Hi-tech Publishing Company Pvt. Ltd. Chennai, 2014
REFERENCES:	
1	R.K. Trivedi, "Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards", Vol. I and II, Enviro Media
2	Rajagopalan, R, "Environmental Studies-From Crisis to Cure", Oxford University Press (2005)
3	Dharmendra S. Sengar, "Environmental law", Prentice hall of India PVT LTD, New Delhi, 2007

Semester III					
Course code	**Course Name**	**Hours/week**			**Credit**
MC2067003	**INTRODUCTION TO BIOLOGY**	**L**	**T**	**P**	**C**
		0	**0**	**0**	**3**

OBJECTIVES

- **Gain knowledge in the fundamentals and uses of biology, human system and plant system.**

UNIT-I	INTRODUCTION TO LIFE	9
Characteristics of living organisms, Basic classification, cell theory, structure of prokaryotic and eukaryotic cell, Introduction to Biomolecules: definition, general classification and important functions of carbohydrates, lipids, proteins, vitamins and enzymes.		
UNIT-II	BIODIVERSITY	9
Plant System: basic concepts of plant growth, nutrition, photosynthesis and nitrogen fixation. Animal System: Elementary study of digestive, respiratory, circulatory, excretory systems and their functions. Microbial System: History, types of microbes, economic importance and control of microbes		
UNIT-III	GENETICS AND EVOLUTION	9
Theories of evolution and Evidences; cell division–mitosis and meiosis; evidence of laws of inheritance; variation and speciation; nucleic acids as a genetic material; central dogma; Mendel laws, gene and chromosomes.		
UNIT-IV	HUMAN DISEASES	9
Definition, causes, symptoms, diagnosis, treatment and prevention of diabetes, cancer, hypertension, influenza, AIDS and Hepatitis. Immunity immunization, antigen –antibody immune response.		
UNIT-V	BIOLOGY AND ITS INDUSTRIAL APPLICATIONS	9
Transgenic plants and animals, stem cell and tissue engineering, bioreactors, bio pharming, recombinant vaccines, cloning, drug discovery, biological neural networks, bioremediation, biofertilizer, biocontrol, biofilters, biosensors, biopolymers, bioenergy, biomaterials and biochips.		
TOTAL HOURS:		**45 PERIODS**

OUTCOME

Student will be able to

1. Apply biological engineering principles, procedures needed to solve real-world problems.
2. Understand the fundamentals of living things, their classification, cell structure and biochemical constituents.
3. Apply the concept of plant, animal and microbial systems and growth in real life situations.
4. Comprehend genetics and the immune system.

5. Know the cause, symptoms, diagnosis and treatment of common diseases. 6. Apply basic knowledge of the applications of biological systems in relevant industries.	
TEXT BOOK :	
1	A Text book of Biotechnology, R.C. Dubey, S. Chand Higher Academic Publications, 2013
2	Diseases of the Human Body, Carol D. Tamparo and Marcia A. Lewis, F.A. Davis Company, 2011
3	Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
REFERENCES:	
1	Cell Biology and Genetics (Biology: The unity and diversity of life Volume I), Cecie Starr, Ralph Taggart, Christine Evers and Lisa Starr, Cengage Learning, 2008.
2	Biotechnology Expanding horizon, B.D. Singh, Kalyani Publishers, 2012

III Semester					
Course Code	**Course Name**	**Hours/Week**			**Credit**
		L	**T**	**P**	**C**
ME2024301	**MANUFACTURING TECHNOLOGY LABORATORY – I**	**0**	**0**	**4**	**2**

Objective(s)

To Study and practice the various operations that can be performed in lathe, shaper, drilling, milling machines etc. and to equip with the practical knowledge required in the core industries.

LIST OF EXPERIMENTS

Machining and Machining time estimations for:

1	Taper Turning
2	External Thread cutting
3	Internal Thread Cutting
4	Eccentric Turning
5	Knurling
6	Drilling, Boring
7	Square Head Shaping
8	V -Groove on Shaping
9	Machining In Capstan Lathe and Turret Lathe
10	Fabrication of simple structural shapes using Gas Metal Arc Welding
11	Preparation of green sand moulds
Total hours :	**30 Periods**

Outcome

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

- Demonstrate the safety precautions exercised in the mechanical workshop.
- Make the work piece as per given shape and size using Lathe.
- Join two metals using arc welding.
- Use sheet metal fabrication tools and make simple tray and funnel.
- Use different moulding tools, patterns and prepare sand moulds.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S. NO.	**NAME OF THE EQUIPMENT**	**Qty.**
1	Centre Lathes	7 Nos.
2	Horizontal Milling Machine	1 No
3	Vertical Milling Machine	1 No

4	Shaper	1 No.
5	Arc welding transformer with cables and holders	2 Nos
6	Oxygen and acetylene gas cylinders, blow pipe and other welding outfit	1 No
7	Moulding table, Moulding equipments	2 Nos
8	Sheet metal forming tools and equipments	2 Nos.

III Semester					
Course code	**Course Name**	**Hours/week**			**Credit**
ME2024302	**COMPUTER AIDED MACHINE DRAWING**	**L**	**T**	**P**	**C**
		0	0	4	2

Objective(s)

- To make the students understand and interpret drawings of machine components
- To prepare assembly drawings both manually and using standard CAD packages

UNIT-I	**DRAWING STANDARDS & FITS AND TOLERANCES**	**12**

Code of practice for Engineering Drawing, BIS specifications – Welding symbols, riveted joints, keys, fasteners – Reference to hand book for the selection of standard components like bolts, nuts, screws, keys etc. - Limits, Fits – Tolerance of individual dimensions – Specification of Fits – Preparation of production drawings and reading of part and assembly drawings, basic principles of geometric dimensioning & tolerance.

UNIT-II	**INTRODUCTION TO 2D DRAFTING**	**16**

Drawing, Editing, Dimensioning, Layering, Hatching, Block, Array, Detailing, Detailed drawing. Bearings - Bush bearing, Plummer block Valves – Safety and non-return valves.

UNIT-III	**3D GEOMETRIC MODELING AND ASSEMBLY**	**32**

Sketcher - Datum planes – Protrusion – Holes - Part modeling – Extrusion – Revolve – Sweep – Loft – Blend – Fillet - Pattern – Chamfer - Round - Mirror – Section – Assembly. Couplings – Flange, Universal, Oldham's, Muff, Gear couplings Joints – Knuckle, Gib & cotter, strap, sleeve & cotter joints Engine parts – Piston, connecting rod, cross-head (vertical and horizontal), stuffing box, multi-plate clutch Miscellaneous machine components – Screw jack, machine vice, tail stock, chuck, vane and gear pump.

Note: 25% of assembly drawings must be done manually and remaining 75% of assembly drawings must be done by using any CAD software. The above tasks can be performed manually and using standard commercial 2D / 3D CAD software.

Total hours:	**60** periods

Outcome

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

- Follow the drawing standards, Fits and Tolerances
- Re-create part drawings, sectional views and assembly drawings as per standards

TEXT BOOK :

1	Gopalakrishna K.R.,"Machine Drawing",22nd Edition,Subhas Stores Books Corner, Bangalore, 2013

REFERENCES:

1	N.D.Bhatt and V.M. Panchal, "Machine Drawing", 48th Edition, Charotar Publishers,2013
2	Junnarkar, N.D., "Machine Drawing", 1st Edition, Pearson Education, 2004
3	N.Siddeshwar, P. Kanniah, V.V.S. Sastri, "Machine Drawing" , published by Tata Mc GrawHill,2006

SEMESTER III					
Course Code	Course Name	Hours/Week			Credit
		L	T	P	C
EE2023301	ELECTRICAL ENGINEERING LABORATORY	0	0	4	2

Objective(s)

- To validate the principles studied in theory by performing experiments in the laboratory

LIST OF EXPERIMENTS	
1	Load test on DC Shunt & DC Series motor
2	O.C.C & Load characteristics of DC Shunt and DC Series generator
3	Speed control of DC shunt motor (Armature, Field control)
4	Load test on single phase transformer
5	O.C & S.C Test on a single phase transformer
6	Regulation of an alternator by EMF & MMF methods.
7	V curves and inverted V curves of synchronous Motor
8	Load test on three phase squirrel cage Induction motor
9	Speed control of three phase slip ring Induction Motor
10	Study of DC & AC Starters
Total hours :	**45 Periods**

OUTCOMES:

- Ability to perform speed characteristic of different electrical machine

V Semester					
Course code	Course Name	Hours/week			Credit
		L	T	P	C
MA2012403	Statistics and Numerical Methods	2	1	0	3

Objectives:

- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

UNIT-I	TESTING OF HYPOTHESIS	12

Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means -Tests based on t, Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.

UNIT-II	DESIGN OF EXPERIMENTS	12

One way and two way classifications - Completely randomized design – Randomized block design – Latin square design - 2^2 factorial design.

UNIT-III	SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS	12

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method - Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.

UNIT-IV	INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION	12

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivates using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

UNIT-V	NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS	12

Single step methods : Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first order equations - Multi step methods : Milne's and Adams - Bash forth predictor corrector methods for solving first order equations.

Total hours:	**60** periods

Outcome

Upon completion of this course , students will be able to

- Apply the concept of testing of hypothesis for small and large samples in real life problems.
- Apply the basic concepts of classifications of design of experiments in the field of agriculture.
- Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.
- Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations
- Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications .

TEXT BOOK :

1	Grewal. B.S. and Grewal. J.S., "Numerical Methods in Engineering and Science ", 10th Edition, Khanna Publishers, New Delhi, 2015.
2	Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015

REFERENCES:

1	Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2	Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
3	Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 2006.
4	Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics ", Tata McGraw Hill Edition, 2004.
5	Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", 8th Edition, Pearson Education, Asia, 2007.

IV Semester

Course code	Course Name	Hours/week			Credit
		L	T	P	C
ME2014401	FLUID MECHANICS AND MACHINERY	3	0	0	3

Objective(s)

- The properties of fluids and concept of control volume are studied
- The applications of the conservation laws to flow through pipes are studied.
- To understand the importance of dimensional analysis.
- To understand the importance of various types of flow in pumps.
- To understand the importance of various types of flow in turbines.

UNIT-I	**FLUID PROPERTIES AND FLOW CHARACTERISTICS**	**12**

Units and dimensions- Properties of fluids- mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapor pressure, surface tension and capillarity, gauge and vacuum pressures – measurement of pressure- Piezometer, U-tube and differential manometers. Flow characteristics – concept of control volume - application of continuity equation

UNIT-II	**FLOW THROUGH CIRCULAR CONDUITS**	**12**

Laminar flow through circular conduits and circular annuli-Boundary layer concepts – types of boundary layer thickness – Darcy Weisbach equation –friction factor- Moody diagram- commercial pipes- minor losses – Flow through pipes in series and parallel.

UNIT-III	**DIMENSIONAL ANALYSIS**	**12**

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

UNIT-IV	**PUMPS**	**12**

Definition and classifications- Centrifugal and Reciprocating Pumps: Working principles-Indicator diagram − Specific speed − efficiency and performance curves - Cavitations in pumps.

UNIT-V	**TURBINES**	**12**

Classification of turbines – heads and efficiencies – velocity triangles. Axial, radial and mixed flow turbines. Pelton wheel, Francis turbine and Kaplan turbines- working principles - work done by water on the runner – draft tube. Specific speed - unit quantities – performance curves for turbines – governing of

turbines.	
Total hours:	**60** periods

Outcome

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

- Apply mathematical knowledge to predict the properties and characteristics of a fluid.
- Can analyse and calculate major and minor losses associated with pipe flow in piping networks.
- Can mathematically predict the nature of physical quantities
- Can critically analyse the performance of pumps
- Can critically analyse the performance of turbines.

TEXT BOOK :

1	Bansal, R.K., Fluid Mechanics and Hydraulics Machines, Laxmi Publications (P) Ltd., IX Edition, New Delhi. 2017.

REFERENCES:

1	Graebel. W.P, "Engineering Fluid Mechanics", Taylor & Francis, Indian Reprint, 2011
2	Kumar K. L., "Engineering Fluid Mechanics", Eurasia Publishing House(p) Ltd., New Delhi 2016
3	Robert W.Fox, Alan T. McDonald, Philip J.Pritchard, “Fluid Mechanics and Machinery”, 2011.
4	Streeter, V. L. and Wylie E. B., "Fluid Mechanics", McGraw Hill Publishing Co. 2010

IV Semester

Course code	Course Name	Hours/week			Credit
		L	T	P	C
ME2014402	STRENGTH OF MATERIALS	3	0	0	3

Objective(s)

- To understand the concepts of stress, strain, principal stresses and principal planes.
- To study the concept of shearing force and bending moment due to external loads in determinate beams and their effect on stresses.
- To determine stresses and deformation in circular shafts and helical spring due to torsion.
- To compute slopes and deflections in determinate beams by various methods.
- To study the stresses and deformations induced in thin and thick shells.

UNIT-I	STRESS, STRAIN AND DEFORMATION OF SOLIDS	9

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumetric strains –Stresses on inclined planes – principal stresses and principal planes – Mohr’s circle of stress.

UNIT-II	TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM	9

Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending– bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stress distribution.

UNIT-III	TORSION	9

Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, carriage springs.

UNIT-IV	DEFLECTION OF BEAMS	9

Double Integration method – Macaulay's method – Area moment method for computation of slopes and deflections in beams - Conjugate beam and strain energy – Maxwell's reciprocal theorems. Columns – End conditions – Equivalent length of a column – Euler equation –Slenderness ratio – Rankine formula for columns.

UNIT-V	THIN CYLINDERS, SPHERES AND THICK CYLINDERS	9

Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure –Deformation in spherical shells – Lame's theorem.

Total hours:	**45** periods

Outcome

- Upon the completion of this course the students will be able to
- Understand the concepts of stress and strain in simple and compound bars, the importance of principal stresses and principal planes.
- Understand the load transferring mechanism in beams and stress distribution due to shearing force and bending moment.
- Apply basic equation of simple torsion in designing of shafts and helical springCalculate the slope and deflection in beams using different methods.
- Analyze and design thin and thick shells for the applied internal and external pressures.

TEXT BOOK :

1	Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2016
2	Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2009

REFERENCES:

1	Egor. P.Popov "Engineering Mechanics of Solids" Prentice Hall of India, New Delhi, 2002.
2	Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing 'co. Ltd., New Delhi, 2005.
3	Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2013
4	Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2010.

IV Semester

Course code	Course Name	Hours/week			Credit
		L	T	P	C
ME2014403	MANUFACTURING TECHNOLOGY – II	3	0	0	3

Objective(s)

- To understand the concept and basic mechanics of metal cutting, working of standard machine tools such as lathe, shaping and allied machines, milling, drilling and allied machines, grinding and allied machines and broaching.
- To understand the basic concepts of Computer Numerical Control (CNC) of machine tools and CNC Programming

UNIT-I	THEORY OF METAL CUTTING	9

Mechanics of chip formation, single point cutting tool, forces in machining, Types of chip, cutting tools– nomenclature, orthogonal metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and Machinability.

UNIT-II	TURNING MACHINES	9
Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, machining time and power estimation. Capstan and turret lathes- tool layout – automatic lathes: semi automatic – single spindle : Swiss type, automatic screw type – multi spindle:		
UNIT-III	**SHAPER, MILLING AND GEAR CUTTING MACHINES**	**9**
Shaper - Types of operations. Drilling, reaming, boring, Tapping. Milling operations-types of milling cutter. Gear cutting – forming and generation principle and construction of gear milling hobbing and gear shaping processes –finishing of gears.		
UNIT-IV	**ABRASIVE PROCESS AND BROACHING**	**9**
Abrasive processes: grinding wheel – specifications and selection, types of grinding process–cylindrical grinding, surface grinding, centreless grinding and internal grinding- Typical applications – concepts of surface integrity, broaching machines: broach construction – push, pull, surface and continuous broaching machines		
UNIT-IV	**CNC MACHINING**	**9**
Numerical Control (NC) machine tools – CNC types, constructional details, special features, machining centre, part programming fundamentals CNC – manual part programming – micromachining – wafer machining.		
	Total hours:	**45** periods

Outcome

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

- explain the mechanism of material removal processes.
- describe the constructional and operational features of centre lathe and other special purpose lathes.
- describe the constructional and operational features of shaper, planner, milling, drilling,
- sawing and broaching machines.
- explain the types of grinding and other super finishing processes apart from gear manufacturing processes.

TEXT BOOK :

1	Hajra Choudhury, "Elements of Workshop Technology", Vol.II., Media Promoters 2014
2	Rao. P.N "Manufacturing Technology - Metal Cutting and Machine Tools", 3 Edition, Tata McGraw-Hill, New Delhi, 2013.

REFERENCES:

1	Richerd R Kibbe, John E. Neely, Roland O. Merges and Warren J.White "Machine Tool
2	Geofrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", Mc Graw Hill, 1984
3	HMT, "Production Technology", Tata McGraw Hill, 1998.
4	Roy. A.Lindberg, "Process and Materials of Manufacture," Fourth Edition, PHI/Pearson Education 2006.

IV Semester					
Course code	**Course Name**	**Hours/week**			**Credit**
		L	**T**	**P**	**C**
ME2014404	**THERMAL ENGINEERING-I**	2	1	0	3

OBJECTIVES:

- To integrate the concepts, laws and methodologies from the first course in thermodynamics into analysis of cyclic processes
- To apply the thermodynamic concepts into various thermal application like IC engines, Steam.
- Turbines, Compressors and Refrigeration and Air conditioning systems (Use of standard refrigerant property data book, Steam Tables, Mollier diagram and Psychrometric chart permitted)

UNIT-I	GAS POWER CYCLES	9

Air Standard Cycles - Otto, Diesel, Dual, Brayton – Cycle Analysis, Performance and Comparison – Rankine, reheat and regenerative cycle.

UNIT-II	AIR COMPRESSORS	9

Classificationand working principle of various types of compressors, work of compression with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency of reciprocating compressors, Multistage air compressor and inter cooling –work of multistage air compressor.

UNIT-III	INTERNAL COMBUSTION ENGINES	9

IC engine – Classification, working, components and their functions. Ideal and actual : Valve and port timing diagrams, p-v diagrams- two stroke & four stroke, and SI & CI engines – comparison. Geometric, operating, and performance comparison of SI and CI engines. Desirable properties and qualities of fuels. Air-fuel ratio calculation – lean and rich mixtures. Combustion in SI & CI Engines – Knocking – phenomena and control..

UNIT-IV	INTERNAL COMBUSTION ENGINE PERFORMANCE AND SYSTEMS	9

Performance parameters and calculations. Morse and Heat Balance tests. Multipoint Fuel Injection system and Common Rail Direct lnjection systems. Ignition systems – Magneto, Battery and Electronic. Lubrication and Cooling systems. Concepts of Supercharging and Turbocharging – Emission Norms.

UNIT-V	UNIT V GAS TURBINES	9

Gas turbine cycle analysis – open and closed cycle. Performance and its improvement - Regenerative, Intercooled, Reheated cycles and their combinations. Materials for Turbines.

Total hours:	**45**periods

Outcome

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

- Apply thermodynamic concepts to different air standard cycles and solve problems.
- solve problems in single stage and multistage air compressors
- Explain the functioning and features of IC engines, components and auxiliaries.
- Calculate performance parameters of IC Engines.
- Explain the flow in Gas turbines and solve problems.

TEXT BOOK :

1	Kothandaraman.C.P., Domkundwar. S,Domkundwar. A.V., “A course in thermal Engineering", Fifth Edition, ”Dhanpat Rai & sons , 2016
2	Rajput. R. K., “Thermal Engineering” S.Chand Publishers, 2017

REFERENCES:

1	Arora.C.P, ”Refrigeration and Air Conditioning ,” Tata McGraw-Hill Publishers 2008
2	Ganesan V..” Internal Combustion Engines” , Third Edition, Tata Mcgraw-Hill 2012
3	Ramalingam. K.K., "Thermal Engineering", SCITECH Publications (India) Pvt. Ltd., 2009
4	Rudramoorthy, R, “Thermal Engineering “,Tata McGraw-Hill, New Delhi,2003

5	Sarkar, B.K,"Thermal Engineering" Tata McGraw-Hill Publishers, 2007

IV Semester					
Course Code	**Course Name**	**Hours/Week**			**Credit**
		L	**T**	**P**	**C**
ME2024401	**MANUFACTURING TECHNOLOGY LABORATORY – II**	**0**	**0**	**4**	**2**

Objective(s)

To Study and practice the various operations that can be performed in lathe, shaper, drilling, milling machines etc. and to equip with the practical knowledge required in the core industries.

LIST OF EXPERIMENTS

Machining and Machining time estimations for:

1	Contour milling using vertical milling machine
2	Spur gear cutting in milling machine
3	Helical Gear Cutting in hobbing machine
4	Groove or slot in milling machine
5	Surface grinding
6	Cylindrical grinding
7	Grinding on given rod by using Centerless grinding machine
8	Make key way by using Slotter
9	Tool angle grinding with tool and Cutter Grinder
10	Measurement of cutting forces in Milling / Turning Process
11	CNC Part Programming
	Total hours : **30 Periods**

Outcome

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

- Demonstrate the safety precautions exercised in the mechanical workshop.
- Make the work piece as per given shape and size using Lathe.
- Join two metals using arc welding.
- Use sheet metal fabrication tools and make simple tray and funnel.
- Use different moulding tools, patterns and prepare sand moulds.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S. NO.	NAME OF THE EQUIPMENT	Qty.
1	Turret and Capstan Lathes	1 No each
2	Horizontal Milling Machine	2 No
3	Vertical Milling Machine	1 No
4	Surface Grinding Machine	1 No.
5	Cylinderical Grinding Machine	1 No.
6	Radial Drilling Machine	1 No.
7	lathe Tool Dynamometer	1 No
8	Milling Tool Dynamometer	1 No

9	Gear Hobbing Machine	1 No
10	Tool Makers Microscope	1 No
11	CNC Lathe	1 No
12	CNC Milling machine	1 No
13	Gear Shaping machine	1 No
14	Centerless grinding machine	1 No
15	Tool and cutter grinder	1 No

IV Semester					
Course Code	**Course Name**	**Hours/Week**			**Credit**
		L	**T**	**P**	**C**
ME2024402	**STRENGTH OF MATERIALS LABORATORY**	**0**	**0**	**4**	**2**

Objective(s)

- To study the mechanical properties of materials when subjected to different types of loading.

LIST OF EXPERIMENTS

1	Tension test on a mild steel rod
2	Double shear test on Mild steel and Aluminium rods
3	Torsion test on mild steel rod
4	Impact test on metal specimen
5	Hardness test on metals - Brinnell and Rockwell Hardness Number
6	Deflection test on beams
7	Compression test on helical springs
8	Tension test on helical springs
9	Effect of hardening- Improvement in hardness and impact resistance of steels.
10	Tempering- Improvement Mechanical properties Comparison (i) Unhardened specimen (ii) Quenched Specimen and (iii) Quenched and tempered specimen.
11	Microscopic Examination of (i) Hardened samples and (ii) Hardened and tempered samples.
Total hours :	**45 Periods**

Outcome

- Ability to perform Tension, Torsion, Hardness, Compression, and Deformation test on Solid materials.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Universal Tensile Testing machine with double 1 shear attachment – 40 Ton Capacity	1
2	Torsion Testing Machine (60 NM Capacity)	1
3	Impact Testing Machine (300 J Capacity)	1
4	Brinell Hardness Testing Machine	1
5	Rockwell Hardness Testing Machine	1
6	Spring Testing Machine for tensile and compressive loads (2500 N)	1
7	Metallurgical Microscopes	3
8	Muffle Furnace (800 C)	1

IV Semester

Course Code	Course Name	Hours/Week			Credit
		L	T	P	C
ME2024403	**THERMAL ENGINEERING LABORATORY**	**0**	**0**	**4**	**2**

Objective(s)

- To understand the thermodynamic concepts used in various thermal applications like IC engines, steam Generator, turbine and other thermal devices.
- To study valve timing diagram and performance of IC Engines
- To learn the characteristics of fuels/Lubricants used in IC Engines
- To analyze the Performance of steam generator/ turbine

LIST OF EXPERIMENTS I.C ENGINE LAB AND FUELS LAB

1	Valve Timing and Port Timing Diagrams.
2	Performance Test on 4-stroke Diesel Engine/Petrol Engine
3	Heat Balance Test on 4-stroke Diesel Engine
4	Morse Test on Multi cylinder Petrol Engine
5	Retardation Test to find Frictional Power of a Diesel Engine
6	Determination of Viscosity – Red Wood Viscometer
7	Determination of Flash Point and Fire Point

STEAM LAB

8	Study of steam generators and turbines
9	Performance and energy balance test on a steam generator
10	Performance and energy balance test on steam turbine

Total hours : **45 Periods**

Outcome

- At the end of this course, the students will be able to conduct tests on heat conduction apparatus and evaluate thermal conductivity of materials.
- Conduct tests on natural and forced convective heat transfer apparatus and evaluate heat transfer coefficient.
- Conduct tests on radiative heat transfer apparatus and evaluate Stefan Boltzmann constant and emissivity.
- Conduct tests to evaluate the performance of parallel/counter flow heat exchanger apparatus and reciprocating air compressor.
- Conduct tests to evaluate the performance of refrigeration and air conditioning test rigs.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

No.	NAME OF THE EQUIPMENT FOR I.C ENGINE LAB AND FUELS LAB	Qty.
1	I.C Engine – 2 stroke and 4 stroke model	1 set
2	Apparatus for Flash and Fire Point	1 No.
3	4-stroke Diesel Engine with mechanical loading.	1 No

4	4-stroke Diesel Engine with hydraulic loading.	1 No.
5	4-stroke Diesel Engine with electrical loading.	1 No.
6	Multi-cylinder Petrol Engine	1 No.
7	Single cylinder Petrol Engine	1 No.
8	Data Acquisition system with any one of the above engines	1 No.
9	Steam Boiler with turbine setup	1 No.

SEMESTER IV					
Course Code	**Course Name**	**Hours/Week**			**Credit**
		L	**T**	**P**	**C**
ME2076401	**INPLANT TRAINING**	**0**	**0**	**0**	**1**

Objective(s)

- To develop the ability to understand and present any technical topic. To train the students in preparing report and to face reviews

INPLANT TRAINING:

Student should undergo training for two weeks continuously in an industry with prior approval from the Head of the Department during their summer/Winter vacation before the start of fifth semester. The student has to submit the certificate received from the industry along with a plant training report and to present a seminar about the training undergone to the Committee constituted by the Head of the Department for evaluation

Total hours :	**45 Periods**

OUTCOMES:

- On Completion of the course students will take on the challenges in the industry, prepare a presentation in a professional manner, and document all aspects

V Semester					
Course code	**Course Name**	**Hours/week**			**Credit**
		L	**T**	**P**	**C**
ME2014501	**Heat and Mass Transfer**	2	1	0	3

Objective(s)

- To understand the mechanisms of heat transfer under steady and transient conditions
- To understand the concepts of heat transfer through extended surfaces
- To learn the thermal analysis and sizing of heat exchangers and to understand the basic concepts of mass transfer.
  (Use of standard HMT data book permitted)

UNIT-I	**CONDUCTION**	**9+6**

General Differential equation of Heat Conduction – Cartesian and Polar Coordinates – One Dimensional Steady State Heat Conduction — plane and Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis– Semi Infinite and Infinite Solids – Use of Heisler's charts.

UNIT-II	**CONVECTION**	**9+6**

Free and Forced Convection – Hydro dynamic and Thermal Boundary Layer. Free and Forced Convection during external flow over Plates and Cylinders and Internal flow through tubes.

UNIT-III	PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS	9+6
Nusselt's theory of condensation – Regimes of Pool boiling and Flow boiling. Correlations in boiling and condensation. Heat Exchanger Types – Overall Heat Transfer Coefficient – Fouling Factors – Analysis – LMTD method - NTUmethod.		
UNIT-IV	**RADIATION**	**9+6**
Black Body Radiation – Grey body radiation – Shape Factor – Electrical Analogy – Radiation Shields. Radiation through gases.		
UNIT-V	**MASS TRANSFER**	**9+6**
Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy –Convective Mass Transfer Correlations.		
Total hours:	**75** periods	

Outcomes

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

- Apply heat conduction equations to different surface configurations under steady state and transient conditions and solve problems
- Apply free and forced convective heat transfer correlations to internal and external flows through/over various surface configurations and solve problems
- Explain the phenomena of boiling and condensation, apply LMTD and NTU methods of thermal analysis to different types of heat exchanger configurations and solve problems
- Explain basic laws for Radiation and apply these principles to radiative heat transfer between different types of surfaces to solve problems
- Apply diffusive and convective mass transfer equations and correlations to solve problems for different applications

TEXT BOOK :

1	Holman, J.P.,"Heat and Mass Transfer",Tata McGraw Hill, 2000
2	Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 5th Edition 2015

REFERENCES:

1	Frank P.Incropera and David P.Dewitt,"Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 1998
2	Kothandaraman,C.P.,"Fundamentals of Heat and Mass Transfer", New Age International, New Delhi,1998
3	Nag, P.K.,"Heat Transfer",Tata McGraw Hill, New Delhi, 2002
4	Ozisik, M.N.,"Heat Transfer", McGraw Hill Book Co.,1994.
5	R.C. Sachdeva, "Fundamentals of Engineering Heat & Mass transfer", New Age International Publishers, 2009

V Semester					
Course code	**Course Name**	**Hours/week**			**Credit**
ME2014502	**DESIGN OF MACHINE ELEMENTS**	**L**	**T**	**P**	**C**

		3	0	0	3

Objective(s)

- 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
- (Use of P S G Design Data Book is permitted)

UNIT-I	**STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS**	**9**

Introduction to the design process -– curved beams – crane hook and 'C' frame- Factor of safety - theories of failure – Design based on strength and stiffness – stress concentration – Design for variable loading

UNIT-II	**SHAFTS AND COUPLINGS**	**9**

Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys, keyways and splines - Rigid and flexible couplings.

UNIT-III	**TEMPORARY AND PERMANENT JOINTS**	**9**

Threaded fastners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints, riveted joints for structures - theory of bonded joints-Computer Aided Design of Joints.

UNIT-IV	**ENERGY STORING ELEMENTS**	**9**

Various types of springs, optimization of helical springs - rubber springs-Computer Aided Design of springs - Flywheels considering stresses in rims and arms for engines and punching machines

UNIT-V	**BEARINGS**	**9**

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi and Boyd graphs, -- Selection of Rolling Contact bearings.

Total hours:	**45** periods

Outcome

- Explain the influence of steady and variable stresses in machine component design.
- Apply the concepts of design to shafts, keys and couplings
- Apply the concepts of design to temporary and permanent joints
- Apply the concepts of design to energy absorbing members
- Apply the concepts of design to bearings.

TEXT BOOK :

1	Bhandari V, "Design of Machine Elements", 4th Edition, Tata McGraw-Hill Book Co, 2016.
2	Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 9th Edition, Tata McGraw-Hill, 2011.

REFERENCES:

1	Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", Tata McGraw-Hill BookCo.(Schaum's Outline), 2010
2	P.C. Gope, "Machine Design – Fundamental and Application", PHI learning private ltd, New Delhi, 2012.
3	R.B. Patel, "Design of Machine Elements", MacMillan Publishers India P Ltd., Tech-Max Educational resources, 2011.
4	Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", 4 2005

V Semester

Course code	Course Name	Hours/week			Credit
		L	T	P	C
ME2014503	METROLOGY AND MEASUREMENTS	3	0	0	3

Objective(s)

- To understand the basic principles of measurements.
- To provide knowledge of various linear and angular measuring equipments and the procedures of measurement
- To provide knowledge on various Metrological equipments available to measure the dimension of the components.
- To provide knowledge on the correct procedure to be adopted to measure the dimension of the components.
- To understand the basics and methods of measurement for power, flow and temperature.

UNIT I	BASICS OF METROLOGY	9

Introduction to Metrology – Generalised Measurement system - Need for measurement -Units and Standards, Types — Control — Calibration. Work piece, Instruments – Persons – Environment – their effect on Precision and Accuracy – Errors – Errors in Measurements – Types – Control.

UNIT II	LINEAR AND ANGULAR MEASUREMENTS	9

Linear Measuring Instruments – Evolution – Types – Classification – Limit gauges – gauge design – terminology – procedure – concepts of interchange ability and selective assembly – Angular measuring instruments – Types – Bevel protractor clinometers angle gauges, spirit levels sine bar Sine centre, Angle Dekkor, Comparators: Mechanical, electrical and Pneumatic. Angle alignment telescope – Autocollimator – Applications.

UNIT III	ADVANCES IN METROLOGY	9

Basic concept of lasers-Advantages of lasers – laser Interferometers – types – DC and AC Lasers interferometer – Applications – Straightness – Alignment tests for machines, on contact measurement. Basic concept of CMM – Types of CMM-Constructional features – Probes – Accessories – Software – Applications – Basic concepts of Machine Vision System – Element. Applications in quality inspection using 1D, 2D and 3D vision systems.

UNIT IV	FORM MEASUREMENT	9

Principles and Methods of straightness – Flatness measurement – Thread measurement, gear measurement, surface finish measurement, Roundness measurement – Applications.

UNIT V	MEASUREMENT OF POWER, FLOW AND TEMPERATURE	9

Force, torque, power - mechanical, Pneumatic, Hydraulic and Electrical type. Flow measurement: Venturimeter, Orifice meter, rotameter, pitot tube – Temperature: bimetallic strip, thermocouples, electrical resistance thermometer – Readability and Reliability.

Total hours:	**45** periods

Outcome

CO1	Describe the concepts of measurements to apply in various metrological instruments
CO2	Outline the principles of linear and angular measurement tools used for industrial applications
CO3	Explain the procedure for conducting computer aided inspection
CO4	Demonstrate the techniques of form measurement used for industrial components
CO5	Discuss various measuring techniques of mechanical properties in industrial applications

TEXT BOOK :

1	Gupta. I.C., "Engineering Metrology", Dhanpatrai Publications, 2005.

2	Jain R.K. "Engineering Metrology", Khanna Publishers, 2009.
REFERENCES:	
1	Alan S. Morris, "The essence of Measurement", Prentice Hall of India 1996.
2	Beckwith, Marangoni, Lienhard, "Mechanical Measurements", Pearson Education, 2014.
3	Charles Reginald Shotbolt, "Metrology f o r Engineers", 5th edition, Cengage Learning ,EMEA,1990.
4	Donald Peckman, "Industrial Instrumentation", Wiley Eastern, 2004.
5	Raghavendra ,Krishnamurthy "Engineering Metrology & Measurements",Oxford Univ.Press, 2013.

V Semester					
Course Code	**Course Name**	**Hours/Week**			**Credit**
ME2014504	**DYNAMICS OF MACHINES**	**L**	**T**	**P**	**C**
		3	0	0	3

Objective(s)

- To understand the force–motion relationship in components subjected to external forces and analysis of standard mechanisms.
- To understand the undesirable effects of unbalances resulting from prescribed motions in mechanism.
- To understand the effect of Dynamics of undesirable vibrations.
- To understand the principles in mechanisms used for speed control and stability control.

UNIT-I	**DYNAMIC FORCE ANALYSIS**	**12**

D' Alembert's principle – Inertia force and Inertia torque – Dynamic analysis of four bar mechanics – Dynamic Analysis of reciprocating engines – Piston effort, Crank effort, Turning moment of crankshaft, Inertia of connecting rod. Turning moment diagrams – Single and multi cylinder engines – Fluctuation of energy – Fly Wheels – Applications in engines and punching presses.

UNIT-II	**BALANCING**	**12**

Static and dynamic balancing – Balancing of rotating masses – Balancing a single cylinder engine – Balancing of Multi–cylinder inline – Partial balancing in engines – Balancing of linkages – Field balancing of discs and rotors.

UNIT-III	**LONGITUDINAL VIBRATION**	**12**

Introduction to vibration – Classification of vibrations – Undamped and Damped free vibration of single degree of freedom systems – Springs in series, springs in parallel and combinations – Viscous damping – Types of damped system.

Forced vibration of single degree of freedom system – Harmonic excitation – Logarithmic decrement – Magnification factor, Vibration isolation and Transmissibility.

UNIT-IV	**TRANSVERSE AND TORSIONAL VIBRATION**	**12**

Transverse vibrations of shafts and beams – Natural frequency – Rayleigh's method – Dunkerly's method – Whirling of shafts.

Torsional vibrations – Equivalent shafts – Single Rotor, Two rotor and Three rotor systems – Free vibration of geared systems.

UNIT-V	MECHANISM FOR CONTROL	12
Governors – Types – Centrifugal governors – Gravity controlled and spring controlled governors – Characteristics – Effect of friction – Calculation of equilibrium speeds and ranges of speed of governors.Gyroscopes –Gyroscopic forces and torques – Gyroscopic stabilization – Gyroscopic effects in Automobiles, ships and airplanes.		
	Total Hours:	**60** Periods

Outcome:

- Calculate static and dynamic forces of mechanisms.
- Calculate the Static and Dynamic balancing masses of engines.
- Analyze the undesirable effects of unbalances resulting from prescribed motions
- Compute the effect of Dynamics of Transverse and Torsional vibration.
- Calculate the speed and lift of the governor and estimate the gyroscopic effect on automobiles, ships and airplanes.

TEXT BOOK :

1	F. B. Sayyad, “Dynamics of Machinery”, McMillan Publishers India Ltd., Tech–Max Educational resources, 2011.
2	Rattan, S.S, “Theory of Machines”, 4th Edition, Tata McGraw–Hill, 2014.
3	Uicker, J.J., Pennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”, 4th Edition, Oxford University Press, 2014.

REFERENCES:

1	Cleghorn. W. L, “Mechanisms of Machines”, Oxford University Press, 2014
2	Ghosh. A and Mallick, A.K., “Theory of Mechanisms and Machines", 3rd Edition Affiliated East–West Pvt. Ltd., New Delhi, 2006.
3	Khurmi, R.S.,”Theory of Machines”, 14th Edition, S Chand Publications, 2005.
4	Rao.J.S. and Dukkipati.R.V. "Mechanisms and Machine Theory", Wiley–Eastern Ltd., New Delhi, 1992.
5	Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw–Hill, 2009.
6	V.Ramamurthi, "Mechanics of Machines", Narosa Publishing House, 2002.

Semester – V

Course Code	Course Name	Hours/Week			Credit
		L	T	P	C
ME2024501	**KINEMATICS AND DYNAMICS LABORATORY**	**0**	**0**	**4**	**2**

Objective(s)

- To supplement the principles learnt in kinematics and Dynamics of Machinery.
- To understand how certain measuring devices are used for dynamic testing.

LIST OF EXPERIMENTS

1	a) Study of gear parameters. b) Experimental study of velocity ratios of simple, compound, Epicyclic and differential gear trains.
2	a)Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker, Oscillating cylinder Mechanisms.

	b) Kinematics of single and double universal joints.
3	a) Determination of Mass moment of inertia of Fly wheel and Axle system. b) Determination of Mass Moment of Inertia of axisymmetric bodies using Turn Table apparatus. c) Determination of Mass Moment of Inertia using bifilar suspension and compound pendulum.
4	Motorized gyroscope – Study of gyroscopic effect and couple.
5	Governor - Determination of range sensitivity, effort etc., for Watts, Porter, Proell, and Hartnell Governors.
6	Cams – Cam profile drawing, Motion curves and study of jump phenomenon
7	a) Single degree of freedom Spring Mass System – Determination of natural Frequency and verification of Laws of springs – Damping coefficient determination. b) Multi degree freedom suspension system – Determination of influence coefficient.
8	a) Determination of torsional natural frequency of single and Double Rotor systems.- Undamped and Damped Natural frequencies. b) Vibration Absorber – Tuned vibration absorber.
9	Vibration of Equivalent Spring mass system – undamped and damped vibration.
10	Whirling of shafts – Determination of critical speeds of shafts with concentrated loads.
11	a) Balancing of rotating masses. b) Balancing of reciprocating masses.
12	a) Transverse vibration of Free-Free beam – with and without concentrated masses. b) Forced Vibration of Cantilever beam – Mode shapes and natural frequencies. c) Determination of transmissibility ratio using vibrating table.
Total hours :	**60 Periods**

Outcome

- Explain gear parameters, kinematics of mechanisms, gyroscopic effect and working of lab equipments.
- Determine mass moment of inertia of mechanical element, governor effort and range sensitivity, natural frequency and damping coefficient, torsional frequency, critical speeds of shafts, balancing mass of rotating and reciprocating masses, and transmissibility ratio.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS		
S.No.	**NAME OF THE EQUIPMENT**	**Qty.**
1	Cam follower setup.	1 No.
2	Motorised gyroscope.	1 No.
3	Governor apparatus - Watt, Porter, Proell and Hartnell governors.	1 No.
4	Whirling of shaft apparatus.	1 No.
5	Dynamic balancing machine.	1 No.
6	Two rotor vibration setup.	1 No.
7	Spring mass vibration system.	1 No.
S.No.	**NAME OF THE EQUIPMENT**	**Qty.**
1	Cam follower setup.	1 No.
2	Motorised gyroscope.	1 No.
3	Governor apparatus - Watt, Porter, Proell and Hartnell governors.	1 No.

Semester-V					
Course Code	Course Name	Hours/Week			Credit
		L	T	P	C
ME2024502	HEAT TRANSFER LABORATORY	0	0	4	2

Objective(s)

To enable the students to

• get practical hands-on training and thermal conductivity measurement using different apparatus

• get practical exposure to determine heat transfer coefficient of convection through tube and cylinder

• get practical knowledge on determining COP and other performance factors of refrigeration and air conditioning

• get practiced in refrigeration and air conditioning systems through performance test

LIST OF EXPERIMENTS

Heat Transfer

1	Thermal conductivity measurement using guarded plate apparatus.
2	Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
3	Determination of heat transfer coefficient under natural convection from a vertical cylinder.
4	Determination of heat transfer coefficient under forced convection from a tube.
5	Heat transfer from pin-fin apparatus (natural and forced convection modes)
6	Determination of Stefan – Boltzmann constant.
7	Determination of emissivity of a grey surface.
8	Effectiveness of Parallel / counter flow heat exchanger.

Refrigeration and Air Conditioning

9	Study of refrigeration and air conditioning systems.
10	Determination of COP of a refrigeration system
11	Experiments on air-conditioning system
12	Performance test on a reciprocating air compressor

Total hours : **45 Periods**

Outcome

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

• conduct thermal conductivity measurement test

• determine heat transfer coefficient of convection of heat through different geometrical areas

• determine the sensitivity of grey surfaces

• conduct refrigeration and airconditioning experiments and determine the COP of the system.

NAME OF THE EQUIPMENT FOR HEAT TRANSFER LAB

1	Guarded plate apparatus	1 No.
2	Lagged pipe apparatus	1 No.
3	Natural convection-vertical cylinder apparatus	1 No.
4	Forced convection inside tube apparatus	1 No.
5	Composite wall apparatus	1 No.
6	Thermal conductivity of insulating powder apparatus	1 No.
7	Pin-fin apparatus	1 No.
8	Stefan-Boltzmann apparatus	1 No.
9	Emissivity measurement apparatus	1 No.
10	Parallel/counter flow heat exchanger apparatus	1 No.
11	Single/two stage reciprocating air compressor	1 No.
12	Refrigeration test rig	1 No.
13	Air-conditioning test rig	1 No.

Semester-V					
Course Code	**Course Name**	**Hours/Week**			**Credit**
		L	**T**	**P**	**C**
ME2024503	**Computational fluid dynamics lab**	**0**	**0**	**4**	**2**

Objective(s)

- To provide students with the necessary skills to use commercial CFD packages
- To carry out research in the area of Computational Fluid Dynamics.
- To solve a variety of flow situations and heat transfer tutorials.

LIST OF EXPERIMENTS
Heat Transfer

1	Determination of pressure, velocity distribution and losses in laminar flow between two parallel plates using numerical simulation software.
2	Determination of pressure, velocity distribution and losses in larminar fluid flow through a circular pipe using numerical simulation software
3	Determination of pressure, velocity distribution and losses in incompressible fluid flow through a venturimeter using numerical simulation software.
4	Determination of pressure, velocity temperature, Mach numbner distribution in a compressible fluid flow through a convergent-divergent zzle,using numerical simulation software
5	Determination ofFlow behaviour of fluid laminar flow over a flat plate numerical simulation software.
6	Determination of pressure, velocity distribution and losses in behaviour of fluid flowing over cylinder / air foil blade using numerical simulation software.
7	Determination of pressure, velocity distribution and losses in flow distribution in a pipe circuit using numerical simulation software.

Total hours : **45 Periods**

Semester-V					
Course Code	**Course Name**	**Hours/Week**			**Credit**
		L	**T**	**P**	**C**
ME2024504	**METROLOGY AND MEASUREMENTS LABORATORY**	**0**	**0**	**4**	**2**

Objective(s)

- To provide exposure to the students with hands on experience in various basic engineering practices such as Civil, Mechanical, Electrical and Electronics Engineering.

1	Calibration and use of measuring instruments – Vernier caliper, micrometer, Vernier height gauge – using gauge blocks
2	Calibration and use of measuring instruments – depth micrometer, bore gauge, telescopic gauge
3	Measurement of linear dimensions using Comparators
4	Measurement of angles using bevel protractor and sine bar

5	Measurement of screw thread parameters – Screw thread Micrometers and Three wire method '(floating carriage micrometer)
6	Measurement of gear parameters – disc micrometers, gear tooth vernier caliper
7	Measurement of features in a prismatic component using Coordinate Measuring Machine (CMM)
8	Programming of CNC Coordinate Measuring Machines for repeated measurements of identical components
9	Non-contact (Optical) measurement using Toolmaker's microscope / Profile projector and Video measurement system.
10	Measurement of Surface finish in components manufactured using various processes (turning, milling, grinding, etc.,) using stylus based instruments.
11	Machine tool metrology – Level tests using precision level; Testing of straightness of a machine tool guide way using Autocollimator, spindle tests.
12	Measurement of force, torque and temperature
	Total hours : **60 Periods**

Outcomes

At the end of this course, the students will be able to

- Measure the gear tooth dimensions, angle using sine bar, straightness and flatness,
- Thread parameters, temperature using thermocouple, force, displacement, torque and vibration.
- Calibrate the vernier, micrometer and slip gauges and setting up the comparator for the inspection.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Micrometer	5
2	Vernier Caliper	5
3	Vernier Height Gauge	2
4	Vernier depth Gauge	2
5	Slip Gauge Set	1
6	Gear Tooth Vernier	1
7	Sine Bar	1
8	Floating Carriage Micrometer	1
9	Profile Projector / Tool Makers Microscope	1
10	Parallel / counter flow heat exchanger apparatus	1
11	Mechanical / Electrical / Pneumatic Comparator	1
12	Autocollimator	1
13	Temperature Measuring Setup	1
14	Force Measuring Setup	1
15	Torque Measuring Setup	1

VI Semester

Course code	Course Name	Hours/week			Credit
		L	T	P	C
ME2014601	DESIGN OF TRANSMISSION SYSTEMS	3	0	0	3

Objective(s)

- To gain knowledge on the principles and procedure for the design of Mechanical power Transmission components.
- To understand the standard procedure available for Design of Transmission of Mechanical elements

- To learn to use standard data and catalogues (Use of P S G Design Data Book permitted)

UNIT-I	DESIGN OF FLEXIBLE ELEMENTS	9

Design of Flat belts and pulleys - Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Design of Transmission chains and Sprockets.

UNIT-II	SPUR GEARS AND PARALLEL AXIS HELICAL GEARS	9

Spur gear Terminology -Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects – Fatigue strength - Factor of safety - Gear materials – Helical gear Terminology-Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces for helical gears.

UNIT-III	BEVEL, WORM GEARS	9

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth.Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits-terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair.

UNIT-IV	GEAR BOXES	9

Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications - Constant mesh gear box - Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.

UNIT-V	CAMS, CLUTCHES AND BRAKES	9

Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches-Electromagnetic clutches. Band and Block brakes - external shoe brakes – Internal expanding shoe brake.

Total hours:	**45** periods

Outcome

- Apply the concepts of design to belts, chains and rope drives
- Apply the concepts of design to spur, helical gears
- Apply the concepts of design to worm and bevel gears
- Apply the concepts of design to gear boxes
- Apply the concepts of design to cams, brakes and clutches

TEXT BOOK :

1	Bhandari V, ―Design of Machine Elements‖, 4th Edition, Tata McGraw-Hill Book Co, 2016.
2	Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett ―Mechanical Engineering Design‖, 8th Edition, Tata McGraw-Hill, 2008.

REFERENCES:

1	Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, ―Design of Machine Elements‖ 8th Edition, Printice Hall, 2003.
2	Orthwein W, ―Machine Component Design‖, Jaico Publishing Co, 2003.
3	Prabhu. T.J., ―Design of Transmission Elements‖, Mani Offset, Chennai, 2000.
4	Robert C. Juvinall and Kurt M. Marshek, ―Fundamentals of Machine Design‖, 4th Edition, Wiley, 2005
5	Sundararajamoorthy T. V, Shanmugam .N, ―Machine Design‖, Anuradha Publications,

	Chennai, 2003.

VI Semester					
Course code	**Course Name**	**Hours/week**			**Credit**
		L	**T**	**P**	**C**
ME2014602	**Computer Aided Design And Manufacturing**	3	0	0	3

Objective(s)

- To provide an overview of how computers are being used in mechanical component design
- To understand the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout & Material Handling system.

UNIT-I	**INTRODUCTION**	**9**

Product cycle- Design process- sequential and concurrent engineering- Computer aided design – CAD system architecture- Computer graphics – co-ordinate systems- 2D and 3D transformations- homogeneous coordinates - introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM –CAD/CAM concepts —Types of production - Manufacturing models and Metrics

UNIT-II	**GEOMETRIC MODELING**	**9**

Representation of curves- Hermite curve- Bezier curve- B-spline curves-rational curves-Techniques for surface modeling – surface patch- Coons and bicubic patches- Bezier and B-spline surfaces. Solid modeling techniques- CSG and B-rep

UNIT-III	**CAD STANDARDS**	**9**

Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange images- Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc. - communication standards.

UNIT-IV	**FUNDAMENTAL OF CNC AND PART PROGRAMING**	**9**

Introduction to NC systems and CNC - Machine axis and Co-ordinate system- CNC machine tools- Principle of operation CNC- Construction features including structure- Drives and CNC controllers- 2D and 3D machining on CNC- Introduction of Part Programming, types - Detailed Manual part programming on Lathe & Milling machines using G codes and M codes- Cutting Cycles, Loops, Sub program and Macros- Introduction of CAM package.

UNIT-V	**CELLULAR MANUFACTURING AND FLEXIBLE MANUFACTURING SYSTEM (FMS)**	**9**

Group Technology(GT),Part Families–Parts Classification and coding–Simple Problems in Opitz Part Coding system–Production flow Analysis–Cellular Manufacturing–Composite part concept–Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control– Quantitative analysis in FMS- layout of configuration – implementation.

Total hours:	**45** periods

Outcome

- Explain the 2D and 3D transformations, clipping algorithm, Manufacturing models and Metrics
- Explain the fundamentals of parametric curves, surfaces and Solids
- Summarize the different types of Standard systems used in CAD
- Apply NC & CNC programming concepts to develop part programme for Lathe & Milling Machines
- Summarize the different types of techniques used in Cellular Manufacturing and FMS

TEXT BOOK :	
1	Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill PublishingCo.2007
2	Mikell.P.Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India, 2008.
3	Radhakrishnan P, SubramanyanS.andRaju V., “CAD/CAM/CIM”, 2nd Edition, New Age International (P) Ltd, New Delhi,2000.
REFERENCES:	
1	Chris McMahon and Jimmie Browne “CAD/CAM Principles", "Practice and Manufacturing management “ Second Edition, Pearson Education, 1999.
2	Donald Hearn and M. Pauline Baker “Computer Graphics”’. Prentice Hall, Inc,1992.
3	Foley, Wan Dam, Feiner and Hughes - "Computer graphics principles & practice" Pearson Education -2003
4	William M Neumann and Robert F.Sproul “Principles of Computer Graphics”, McGraw Hill Book Co. Singapore, 1989.

VI Semester					
Course code	**Course Name**	**Hours/week**			**Credit**
		L	**T**	**P**	**C**
ME2014603	**Thermal Engineering – II**	3	0	0	3

Objective(s)

- To apply the thermodynamic concepts for Nozzles, Boilers, Turbines, and Refrigeration & Air Conditioning Systems.
- To understand the concept of utilising residual heat in thermal systems.

UNIT-I	**STEAM NOZZLE**	**9**
Types and Shapes of nozzles, Flow of steam through nozzles, Critical pressure ratio, Variation of mass flow rate with pressure ratio. Effect of friction. Metastable flow.		
UNIT-II	**BOILERS**	**9**
Types and comparison. Mountings and Accessories. Fuels - Solid, Liquid and Gas. Performance calculations, Boiler trial.		
UNIT-III	**STEAM TURBINES**	**9**
Types, Impulse and reaction principles, Velocity diagrams, Work done and efficiency – optimal operating conditions. Multi-staging, compounding and governing.		
UNIT-IV	**COGENERATION AND RESIDUAL HEAT RECOVERY**	**9**
Cogeneration Principles, Cycle Analysis, Applications, Source and utilisation of residual heat. Heat pipes, Heat pumps, Recuperative and Regenerative heat exchangers. Economic Aspects.		
UNIT-V	**REFRIGERATION AND AIR – CONDITIONING**	**9**

Vapour compression refrigeration cycle, Effect of Superheat and Sub-cooling, Performance calculations, Working principle of air cycle, vapour absorption system, and Thermoelectric refrigeration. Air conditioning systems, concept of RSHF, GSHF and ESHF, Cooling load calculations. Cooling towers – concept and types.

Total hours:	**45** periods

Outcome

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

- Solve problems in Steam Nozzle
- Explain the functioning and features of different types of Boilers and auxiliaries and calculate performance parameters.
- Explain the flow in steam turbines, draw velocity diagrams for steam turbines and solve problems.
- Summarize the concept of Cogeneration, Working features of Heat pumps and Heat exchangers
- Solve problems using refrigerant table / charts and psychrometric charts

TEXT BOOK :

1	Kothandaraman, C.P., Domkundwar .S and Domkundwar A.V.,"A course in Thermal Engineering", Dhanpat Rai & Sons, 2016.
2	Mahesh. M. Rathore, "Thermal Engineering", 1st Edition, Tata Mc Graw Hill Publications, 2010.

REFERENCES:

1	Arora .C.P., "Refrigeration and Air Conditioning", Tata Mc Graw Hill, 2008
2	Ballaney. P.L ." Thermal Engineering", Khanna publishers, 24th Edition 2012
3	Charles H Butler : Cogeneration" McGraw Hill, 1984.
4	Donald Q. Kern, " Process Heat Transfer", Tata Mc Graw Hill, 2001.
5	Sydney Reiter "Industrial and Commercial Heat Recovery Systems" Van Nostrand Reinhols, 1985.

VI Semester

Course Code	Course Name	Hours/Week			Credit
		L	T	P	C
ME2014604	**FINITE ELEMENT ANALYSIS**	3	0	0	3

Objective(s)

- To introduce the concepts of Mathematical Modeling of Engineering Problems.
- To appreciate the use of FEM to a range of Engineering Problems.

UNIT-I	**INTRODUCTION**	**9**

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Weighted Residual Methods – Ritz Technique - Variational Formulation of Boundary Value Problems – Galerkin, Sub domain, least square and collocation method – Basic concepts of the FEM.

UNIT-II	**ONE-DIMENSIONAL PROBLEMS**	**9**

Discretization – Element types - Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors - Assembly of Matrices – Assembly of Global equations - Solution of problems from solid mechanics and heat transfer - Longitudinal vibration frequencies and mode shapes - Fourth Order Beam Equation.

UNIT-III	**TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS**	**9**

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation – Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors - Element equations, Load vectors and boundary conditions – Assembly – Application to Hear transfer.

UNIT-IV	**TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS**	**9**

Equations of elasticity – Plane Stress, Plane Strain and Axisymmetric problems – Body forces and temperature effects – Formulation – Element Matrices – Assembly – Boundary Conditions and Solutions.

UNIT-V	**ISOPARAMETRIC FORMULATION**	**9**

Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.

Total Hours: **45** Periods

Outcome:

- Summarize the basics of finite element formulation.
- Apply finite element formulations to solve one dimensional Problems.
- Apply finite element formulations to solve two dimensional scalar Problems.
- Apply finite element method to solve two dimensional Vector problems.
- Apply finite element method to solve problems on iso parametric element and dynamic Problems.

TEXT BOOK :

1	Reddy. J.N., “An Introduction to the Finite Element Method”, 3rd Edition, Tata McGraw-Hill, 2005
2	Seshu, P, “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.

REFERENCES:

1	Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons, 2005 (Indian Reprint 2013)
2	Chandrupatla & Belagundu, “Introduction to Finite Elements in Engineering”, 3rd Edition, Prentice Hall College Div, 1990
3	Logan, D.L., “A first course in Finite Element Method”, Thomson Asia Pvt. Ltd., 2002
4	Rao, S.S., “The Finite Element Method in Engineering”, 3rd Edition, Butterworth Heinemann, 2004
5	Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, “Concepts and Applications of Finite Element Analysis”, 4th Edition, Wiley Student Edition, 2002.

Semester – VI					
Course Code	**Course Name**	**Hours/Week**			**Credit**
		L	**T**	**P**	**C**
ME2024601	**CAD / CAM LABORATORY**	**0**	**0**	**4**	**2**

Objective(s)

- To gain practical experience in handling 2D drafting and 3D modelling software systems.
- To study the features of CNC Machine Tool.
- To expose students to modern control systems (Fanuc, Siemens etc.,)
- To know the application of various CNC machines like CNC lathe, CNC Vertical Machining centre, CNC EDM and CNC wire-cut and studying of Rapid prototyping.

LIST OF EXPERIMENTS	
3D GEOMETRIC MODELLING	
1	Introduction of 3D Modelling software
Creation of 3D assembly model of following machine elements using 3D Modelling software	
2	Flange Coupling
3	Plummer Block
4	Screw Jack
5	Lathe Tailstock
6	Universal Joint
7	Machine Vice
8	Stuffing box
9	Crosshead
10	Safety Valves
11	Non-return valves
12	Connecting rod
13	Piston
14	Crankshaft
MANUAL PART PROGRAMMING	
15	Part Programming - CNC Machining Centre a) Linear Cutting. b) Circular cutting. c) Cutter Radius Compensation. d) Canned Cycle Operations.
16	Part Programming - CNC Turning Centre a) Straight, Taper and Radius Turning. b) Thread Cutting. c) Rough and Finish Turning Cycle. d) Drilling and Tapping Cycle.
17	Computer Aided Part Programming a) CL Data and Post process generation using CAM packages. b) Application of CAPP in Machining and Turning Centre.
Total hours :	**60 Periods**

Outcome

- Draw 3D and Assembly drawing using CAD software
- Demonstrate manual part programming with G and M codes using CAM

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	Description of Equipment	Qty
	HARDWARE	
1.	Computer Server	1
2.	Computer nodes or systems (High end CPU with atleast 1 GB main memory) networked to the server	30
3.	A3 size plotter	1
4.	Laser Printer	1
5.	CNC Lathe	1
6.	CNC milling machine	1
	SOFTWARE	
7.	Any High end integrated modeling and manufacturing CAD / CAM software	15 licenses
8.	CAM Software for machining centre and turning centre (CNC Programming and tool path simulation for FANUC / Sinumeric and Heidenhain controller)	15 licenses
9.	Licensed operating system	Adequate
10.	Support for CAPP	Adequate

Semester-VI

Course code	Course Name	Hours/week			Credit
		L	T	P	C
ME2024602	Design and Fabrication Project	0	0	4	2

Objective(s)

- The main objective is to give an opportunity to the student to get hands on training in the fabrication of one or more components of a complete working model, which is designed by them.

Total hours: **60** periods

Outcome

- Design and fabricate the machine element or the mechanical product.
- Demonstrate the working model of the machine element or the mechanical product.

Guideline for Review and Evaluation

- The students may be grouped into 2 to 4 and work under a project supervisor.
- The device/ system/component(s) to be fabricated may be decided in consultation with the supervisor and if possible with an industry.
- A project report to be submitted by the group and the fabricated model, which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department.
- At the end of the semester examination the project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department

Semester-VI

Course code	Course Name	Hours/week			Credit
		L	T	P	C
EN2021601	PROFESSIONAL COMMUNICATION	0	0	0	0

OBJECTIVES: • Enhance the Employability and Career Skills of students • Orient the students towards grooming as a professional • Make them Employable Graduates • Develop their confidence and help them attend interviews successfully.		
UNIT-I		**6**
Introduction to Soft Skills-- Hard skills & soft skills - employability and career Skills—Grooming as a professional with values—Time Management—General awareness of Current Affairs		
UNIT-II		**6**
Self-Introduction-organizing the material - Introducing oneself to the audience – introducing the topic – answering questions – individual presentation practice— presenting the visuals effectively –5 minute presentations		
UNIT-III		**6**
Introduction to Group Discussion— Participating in group discussions – understanding group dynamics - brainstorming the topic -– questioning and clarifying G–D strategies- activities to improve GD skills		
UNIT-IV		**6**
Interview etiquette – dress code – body language – attending job interviews– telephone/skype interview -one to one interview &panel interview – FAQs related to job interviews		
UNIT-V		**6**
Recognizing differences between groups and teams- managing time-managing stress- networking professionally- respecting social protocols-understanding career management-developing a long term career plan-making career changes		
Total hours:	**30** periods	
Outcome • Apply the concept of compressible flows in variable area ducts. • Apply the concept of compressible flows in constant area ducts. • Examine the effect of compression and expansion waves in compressible flow. • Use the concept of gas dynamics in Jet Propulsion. • Apply the concept of gas dynamics in Space Propulsion.		

Professional Electives (PE)
Semester-VI
Professional Elective-1

VI Semester (Professional Elective – I)					
Course code	**Course Name**	**Hours/week**			**Credit**
ME2014601	**Automobile Engineering**	**L**	**T**	**P**	**C**
		3	0	0	3
Objective(s) • To understand the construction and working principle of various parts of an automobile. • To have the practice for assembling and dismantling of engine parts and transmission system					
UNIT-I	**VEHICLE STRUCTURE AND ENGINES**				**9**

Types of automobiles vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved), IC engines –components-functions and materials, variable valve timing (VVT) - chassis-specifications,cooling system-Antifreezing compounds.

UNIT-II	ENGINE AUXILIARY SYSTEMS	9

Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT), Engine emission control by three way catalytic converter system, Emission norms (Euro and BS).

UNIT-III	TRANSMISSION SYSTEMS	9

Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

UNIT-IV	STEERING, BRAKES AND SUSPENSION SYSTEMS	9

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	9

Use of NaturalGas, Liquefied Petroleum Gas, Bio-diesel, Bio ethanol, Gasohol and Hydrogen in Automobiles- Engine modifications required –Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels - Electric and Hybrid Vehicles, Fuel Cell Note: Practical Training in dismantling and assembling of Engine parts and Transmission Systems should be given to the students.

Total hours:	**45** periods

Outcome

- Recognize the various parts of the automobile and their functions and materials.
- Discuss the engine auxiliary systems and engine emission control.
- Distinguish the working of different types of transmission systems.
- Explain the Steering, Brakes and Suspension Systems.
- Predict possible alternate sources of energy for IC Engines.

TEXT BOOK :

1	Jain K.K. and Asthana .R.B, “Automobile Engineering” Tata McGraw Hill Publishers, New Delhi, 2002.
2	Kirpal Singh, “Automobile Engineering”, Vol 1 & 2, Seventh Edition, Standard Publishers,

	New Delhi, 13th Edition 2014.
REFERENCES:	
1	Ganesan V. "Internal Combustion Engines", Third Edition, Tata McGraw-Hill, 2012.
2	Heinz Heisler, "Advanced Engine Technology," SAE International Publications USA, 1998.
3	Joseph Heitner, "Automotive Mechanics," Second Edition, East-West Press, 1999.
4	Martin W, Stockel and Martin T Stockle , "Automotive Mechanics Fundamentals," The Good heart - Will Cox Company Inc, USA ,1978

VI Semester (Professional Elective – I)					
Course code	**Course Name**	**Hours/week**			**Credit**
ME2014602	**Welding Technology**	**L**	**T**	**P**	**C**
		3	0	0	3

Objective(s)

- To understand the basics of welding and to know about the various types of welding processes

UNIT-I	**GAS AND ARC WELDING PROCESSES**	**9**

Fundamental principles – Air Acetylene welding, Oxyacetylene welding, Carbon arc welding, Shielded metal arc welding, Submerged arc welding, TIG & MIG welding, Plasma arc welding and Electroslag welding processes - advantages, limitations and applications.

UNIT-II	**RESISTANCE WELDING PROCESSES**	**9**

Spot welding, Seam welding, Projection welding, Resistance Butt welding, Flash Butt welding, Percussion welding and High frequency resistance welding processes - advantages, limitations and applications.

UNIT-III	**SOLID STATE WELDING PROCESSES**	**9**

Cold welding, Diffusion bonding, Explosive welding, Ultrasonic welding, Friction welding, Forge welding, Roll welding and Hot pressure welding processes - advantages, limitations and applications.

UNIT-IV	**OTHER WELDING PROCESSES**	**9**

Thermit welding, Atomic hydrogen welding, Electron beam welding, Laser Beam welding, Friction stir welding, Under Water welding, Welding automation in aerospace, nuclear and surface transport vehicles.

UNIT-V	**DESIGN OF WELD JOINTS, WELDABILITY AND TESTING OF WELDMENTS**	**9**

Various weld joint designs – Welding defects – causes and remedies - Weldability of Aluminium, Copper, and Stainless steels. Destructive and non destructive testing of weldments

Total hours:	**45** periods

Outcome

Upon completion of this course, the students can able

- Understand the construction and working principles of gas and arc welding process.
- Understand the construction and working principles of resistance welding process.
- Understand the construction and working principles of various solid state welding process.
- Understand the construction and working principles of various special welding processes.
- Understand the concepts on weld joint design, weldability and testing of weldments.

TEXT BOOK :

1	Little R.L., "Welding and welding Technology", Tata McGraw Hill Publishing Co., Ltd., New Delhi, 34th reprint, 2008.
2	Parmer R.S., "Welding Engineering and Technology", 1st Edition, Khanna Publishers, New Delhi, 2008.
3	Parmer R.S., "Welding Processes and Technology", Khanna Publishers, New Delhi, 1992.

REFERENCES:

1	AWS- Welding Hand Book. 8th Edition. Vol- 2. "Welding Process"
2	Christopher Davis. "Laser Welding- Practical Guide". Jaico Publishing House.
3	Davis A.C., "The Science and Practice of Welding", Cambridge University Press, Cambridge, 1993.
4	Nadkarni S.V. "Modern Arc Welding Technology", Oxford IBH Publishers, 1st Edition, 2005.
5	Schwartz M.M. "Metals Joining Manual". McGraw Hill Books, 1979.
6	Tylecote R.F. "The Solid Phase Welding of Metals". Edward Arnold Publishers Ltd. London.

VI Semester (Professional Elective – I)

Course code	Course Name	Hours/week			Credit
		L	T	P	C
ME2014603	**Gas Dynamics and Jet Propulsion**	3	0	0	3

Objective(s)

- To understand the basic difference between incompressible and compressible flow
- To understand the phenomenon of shock waves and its effect on flow.
- To gain some basic knowledge about jet propulsion and Rocket Propulsion.(Use of Standard Gas Tables permitted)

UNIT-I	**BASIC CONCEPTS AND ISENTROPIC FLOWS**	**9**

Energy and momentum equations of compressible fluid flows–Stagnation states, Mach waves and Mach cone – Effect of Mach number on compressibility – Isentropic flow through variable ducts – Nozzle and Diffusers

UNIT-II	**FLOW THROUGH DUCTS**	**9**

Flows through constant area ducts with heat transfer (Rayleighflow) and Friction(Fannoflow) – variation off low properties.		
UNIT-III	**NORMAL AND OBLIQUE SHOCKS**	**9**
Governing equations – Variation off low parameters across the normal and oblique shocks – Prandtl – Meyer relations – Applications.		
UNIT-IV	**JET PROPULSION**	**9**
Theory of jet propulsion – Thrustequation – Thrust power and propulsive efficiency –Operating principle, cycle analysis and use of stagnation state performance of ram jet, turbo jet, turbo fan and turbo prop engines.		
UNIT-V	**SPACE PROPULSION**	**9**
Types of rocket engines – Propellants – feeding systems – Ignition and combustion–Theory of rocket propulsion – Performance study – Staging –Terminal and characteristic velocity – Applications – spaceflights.		
	Total hours:	**45** periods

Outcome

- Apply the concept of compressible flows in variable area ducts.
- Apply the concept of compressible flows in constant area ducts.
- Examine the effect of compression and expansion waves in compressible flow.
- Use the concept of gas dynamics in Jet Propulsion.
- Apply the concept of gas dynamics in Space Propulsion.

TEXT BOOK :

1	Anderson, J.D.,"Modern Compressible flow",3rd Edition, McGrawHill, 2012.
2	Yahya,S.M."Fundamentals of Compressible Flow", New Age International(P)Limited, New Delhi, 2002

REFERENCES:

1	Cohen.H.,G.E.C.RogersandSaravanamutto,"GasTurbineTheory",LongmanGroupLtd.,1980
2	Ganesan. V., "GasTurbines",TataMcGrawHill PublishingCo.,NewDelhi,2010.
3	Shapiro.A.H.,"DynamicsandThermodynamicsofCompressiblefluidFlow",Johnwiley,New York, 1953.
4	Sutton.G.P., "RocketPropulsionElements", Johnwiley,NewYork,2010,.
5	Zucrow.N.J., "PrinciplesofJetPropulsionandGasTurbines", JohnWiley, NewYork, 1970

VI Semester (Professional Elective – I)					
Course code	**Course Name**	**Hours/week**			**Credit**
		L	**T**	**P**	**C**
ME2014604	**INTELLECTUAL PROPERTY RIGHTS**	3	0	0	3

Objective

- To give an idea about IPR, registration and its enforcement.

UNIT-I	INTRODUCTION	9
Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR- Management and valuation of intellectual property.		
UNIT-II	**REGISTRATION OF IPRs**	**9**
Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad		
UNIT-III	**AGREEMENTS AND LEGISLATIONS**	**9**
International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act , changes in legal and judicial system		
UNIT-IV	**DIGITAL PRODUCTS AND LAW**	**9**
Legal agreements for digital products- Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.		
UNIT-V	**ENFORCEMENT OF IPRs**	**9**
Infringement of IPRs, Arbitration and Mediation of Intellectual Property Disputes- Enforcement Measures, Emerging issues – Case Studies.		
	Total hours:	**45** periods

Outcome

- Ability to manage Intellectual Property portfolio to enhance the value of the firm

TEXT BOOKS :

1	S.V. Satarkar, Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi, 2002.
2	V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012

REFERENCES:

1	Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets", Cengage Learning, Third Edition, 2012.
2	Prabuddha Ganguli,"Intellectual Property Rights: Unleashing the Knowledge Economy", McGraw Hill Education, 2011.
3	Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013

VI Semester (Professional Elective – I)

Course code	Course Name	Hours/week			Credit
		L	T	P	C
ME2014605	FUNDAMENTALS OF NANOSCIENCE	3	0	0	3

Objective(s)

- To learn about basis of nano material science, preparation method, types and application

UNIT-I	INTRODUCTION	8
Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering- Classifications of nanostructure materials- nano particles- quantum dots, nanowires-ultra-thinfilms-multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).		
UNIT-II	**GENERAL METHODS OF PREPARATION**	**9**
Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.		
UNIT-III	**NANOMATERIALS**	**12**
Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides-ZnO, TiO2,MgO, ZrO2, NiO, nanoalumina, CaO, AgTiO2, Ferrites, Nanoclays- functionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications.		
UNIT-IV	**CHARACTERIZATION TECHNIQUES**	**9**
X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation.		
UNIT-V	**APPLICATIONS**	**7**
NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery.		
	Total hours:	45 periods

Outcome

- Will familiarize about the science of nanomaterials.
- Will demonstrate the preparation of nanomaterials.
- Will develop knowledge in characteristic nanomaterial.

TEXT BOOK :

1	A.S. Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia, 1996.
2	N John Dinardo, "Nanoscale Characterization of surfaces & Interfaces", 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000.

REFERENCES:

1	G Timp, "Nanotechnology", AIP press/Springer, 1999.
2	Akhlesh Lakhtakia, "The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations". Prentice-Hall of India (P) Ltd, New Delhi, 2007.

VI Semester (Professional Elective – I)			
Course code	**Course Name**	**Hours/week**	**Credit**

ME2014606	PRINCIPLES OF MANAGEMENT	L	T	P	C
		3	0	0	3

Objective(s)

- To enable the students to study the evolution of Management, to study the functions and principles of management and to learn the application of the principles in an organization.

UNIT-I	INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS	8

Definition of Management – Science or Art – Manager Vs Entrepreneur - types of managers - managerial roles and skills – Evolution of Management – Scientific, human relations, system andcontingency approaches – Types of Business organization - Sole proprietorship, partnership,company-public and private sector enterprises - Organization culture and Environment – Current trends and issues in Management.

UNIT-II	PLANNING	9

Nature and purpose of planning – planning process – types of planning – objectives – setting objectives – policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.

UNIT-III	ORGANISING	12

Nature and purpose – Formal and informal organization – organization chart – organization structure – types – Line and staff authority – departmentalization – delegation of authority – centralization an decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and evelopment, Performance Management, Career planning and management

UNIT-IV	DIRECTING	9

Foundations of individual and group behaviour – motivation – motivation theories – motivational techniques – job satisfaction – job enrichment – leadership – types and theories of leadership – communication – process of communication – barrier in communication – effective communication – communication and IT.

UNIT-V	CONTROLLING	7

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.

Total hours:	45 periods

Outcome

- Upon completion of the course, students will be able to have clear understanding
- Managerial functions like planning, organizing, staffing, leading & controlling and have same basic knowledge on international aspect of management

TEXT BOOK :

1	Stephen P. Robbins & Mary Coulter, ―Management‖, Prentice Hall (India) Pvt. Ltd., 10th Edition, 2009.
2	JAF Stoner, Freeman R.E and Daniel R Gilbert ―Management‖, Pearson Education, 6th Edition, 2004.

REFERENCES:

1	Stephen A. Robbins & David A. Decenzo & Mary Coulter, ―Fundamentals of Management‖ Pearson Education, 7th Edition, 2011.
2	Robert Kreitner & Mamata Mohapatra, ― Management‖, Biztantra, 2008.
3	Harold Koontz & Heinz Weihrich ―Essentials of management‖ Tata McGraw Hill,1998
4	Tripathy PC & Reddy PN, ―Principles of Management‖, Tata McGraw Hill, 1999

VI Semester (Professional Elective – I)					
Course code	**Course Name**	**Hours/week**			**Credit**
ME2014607	**Disaster Management**	**L**	**T**	**P**	**C**
		3	0	0	3

Objective(s)

- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- To enhance awareness of institutional processes in the country
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

UNIT-I	**INTRODUCTION TO DISASTERS**	**9**

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters,Climate change- Dos and Don'ts during various types of Disasters.

UNIT-II	**APPROACHES TO DISASTER RISK REDUCTION (DRR)**	**9**

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, States, Centre, and other stake-holders- Institutional Processess and Framework at State and Central Level- State Disaster Management Authority(SDMA) – Early Warning System – Advisories from Appropriate Agencies.

UNIT-III	**INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT**	**9**

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT-IV	**DISASTER RISK MANAGEMENT IN INDIA**	**9**

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

UNIT-V	**DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS**	**9**

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies.

Total hours:	**45** periods

Outcome

- Differentiate the types of disasters, causes and their impact on environment and society.
- Assess vulnerability and various methods of risk reduction measures as well as mitigation.
- Draw the hazard and vulnerability profile of India, Scenarious in the Indian context, Disaster damage assessment and management.

TEXT BOOK :

1	Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011
2	Kapur Anu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, New Delhi, 2010.
3	Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
4	Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2012. ISBN-10: 1259007367, ISBN-13: 978-1259007361]

REFERENCES:

1	Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005
2	Government of India, National Disaster Management Policy,2009.

VI Semester (Professional Elective – I)

Course code	Course Name	Hours/week			Credit
		L	T	P	C
ME2014608	HYDRAULICS AND PNEUMATICS	3	0	0	3

Objective(s)

- To provide student with knowledge on the application of fluid power in process, construction and manufacturing Industries.
- To provide students with an understanding of the fluids and components utilized in modern industrial fluid power system.
- To develop a measurable degree of competence in the design, construction and operation of fluid power circuits.

UNIT-I	FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS	9

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

UNIT-II	HYDRAULIC ACTUATORS AND CONTROL COMPONENTS	9

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.

UNIT-III	HYDRAULIC CIRCUITS AND SYSTEMS	9

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double-Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

UNIT-IV	**PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS**	**9**

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits.

UNIT-V	**TROUBLE SHOOTING AND APPLICATIONS**	**9**

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

Total hours:	**45** periods

Outcome

- Explain the Fluid power and operation of different types of pumps.
- Summarize the features and functions of Hydraulic motors, actuators and Flow control valves
- Explain the different types of Hydraulic circuits and systems
- Explain the working of different pneumatic circuits and systems
- Summarize the various trouble shooting methods and applications of hydraulic and pneumatic systems.

TEXT BOOK :

1	Anthony Esposito, “Fluid Power with Applications”, Pearson Education 2005.
2	Majumdar S.R.,“Oil Hydraulics Systems- Principles and Maintenance”, Tata McGraw- Hill, 2001.

REFERENCES:

1	Anthony Lal, “Oil hydraulics in the service of industry”, Allied publishers, 1982.
2	Dudelyt, A. Pease and John T. Pippenger, “Basic Fluid Power”, Prentice Hall, 1987.
3	Majumdar S.R., “Pneumatic systems – Principles and maintenance”, Tata McGraw Hill, 1995
4	Michael J, Prinches and Ashby J. G, “Power Hydraulics”, Prentice Hall, 1989.

V Semester(Open Elective-I)

Course code	Course Name	Hours/week			Credit
		L	T	P	C
ME2010001	RENEWABLE ENERGY SOURCES	3	0	0	3

OBJECTIVES:

- To get exposure on solar radiation and its environmental impact to power.
- To know about the various collectors used for storing solar energy.
- To know about the various applications in solar energy.
- To learn about the wind energy and biomass and its economic aspects. circuits.

UNIT-I	PRINCIPLES OF SOLAR RADIATION	10
Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.		
UNIT-II	**SOLAR ENERGY COLLECTION**	**8**
Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.		
UNIT-III	**SOLAR ENERGY STORAGE AND APPLICATIONS**	**7**
Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.		
UNIT-IV	**WIND ENERGY**	**10**
Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria BIO-MASS: Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C.Engine operation and economic aspects.		
UNIT-V	**GEOTHERMAL ENERGY**	**9**
Resources, types of wells, methods of harnessing the energy, potential in India. OCEAN ENERGY: OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics. DIRECT ENERGY CONVERSION: Need for DEC, Carnot cycle, limitations, principles of DEC.		
	Total hours:	45 periods

OUTCOMES:

- Understanding the physics of solar radiation.
- Ability to classify the solar energy collectors and methodologies of storing solar energy.
- Knowledge in applying solar energy in a useful way.
- Knowledge in wind energy and biomass with its economic aspects.
- Knowledge in capturing and applying other forms of energy sources like wind, biogas and geothermal energies.

TEXT BOOK :

1	Rai G.D. , “Non-Conventional Energy Sources”, Khanna Publishers, 2011
2	Twidell & Wier, “Renewable Energy Resources”, CRC Press (Taylor & Francis), 2011

REFERENCES:

1	Tiwari and Ghosal, “Renewable energy resources”, Narosa Publishing House, 2007
2	Ramesh R & Kumar K.U , “Renewable Energy Technologies”,Narosa Publishing House, 2004
3	Mittal K M , “Non-Conventional Energy Systems”, Wheeler Publishing Co. Ltd, New Delhi, 2003
4	Kothari D.P, Singhal ., K.C., “Renewable energy sources and emerging technologies”, P.H.I, New Delhi, 2010

V Semester(Open Elective-I)

Course code	Course Name	Hours/week			Credit
		L	T	P	C
ME2010002	WASTE MANAGEMENT AND ENERGY RECOVERY	3	0	0	3

Objective

- To provide information on various methods of waste management.
- To familiarize students with recent energy generation techniques.
- To detail on the recent technologies of waste disposal
- To make student realize on the importance of healthy environment

UNIT-I	CHARACTERISTICS AND PERSPECTIVES	12
Sources – Types – Composition – Generation – Estimation Techniques – Characterization – Types of Collection System – Transfer Stations – Transfer Operations – Material Recycle / Recovery Facilities**.**		
UNIT-II	**UNIT OPERATIONS & TRANSFORMATION TECHNOLOGIES**	**12**
Separation & Processing : Size Reduction – Separation through Density Variation, Magnetic / Electric Field : Densification - Physical, Chemical and Biological Properties and Transformation Technologies – Selection of Proper Mix of Technologies.		
UNIT-III	**WASTE DISPOSAL**	**12**
Landfill Classification – Types – Siting Considerations – Landfill Gas (Generation, Extraction, Gas Usage Techniques) – Leachates Formation, Movement, Control Techniques – Environmental Quality Monitoring – Layout, Closure & Post Closure Operation – Reclamation.		
UNIT-IV	**TRANSFORMATION TECHNOLOGIES AND VALUE ADDITION**	**12**
Physical Transformation : Component Separation & Volume Reduction : Chemical Transformation – Combustion/Gasification/ Pyrolysis : Energy Recovery - Biological Transformation – Aerobic Composting – Anaerobic Digestion.		
UNIT-V	**HAZARDOUS WASTE MANAGEMENT & WASTE RECYCLING**	**12**
Definition – Sources – Classification – Incineration Technology - Incineration vs Combustion Technology – RDF / Mass Firing – Material Recycling : Paper / Glass / Plastics etc., - Disposal of White Goods & E-Wastes.		
Total hours:	60 periods	

TEXT BOOK :

1	Energy Cogeneration Hand book, George Polimveros, Industrial Press Inc, New York 1982.
2	Howard S. Peavy etal, “Environmental Engineering”, McGraw Hill International Edition, 1985.
3	LaGrega, M., et al., “Hazardous Waste Management”, McGraw-Hill, c. 1200 pp., 2nd ed.,2001., 2001.
4	Manoj Datta, “Waste Disposal in Engineered Landfills”, Narosa Publishing House, 1997.

REFERENCES:

1	Parker Colin and Roberts, “Energy from Waste –An Evaluation of Conversion Technologies” ,Elsevier Applied Science, London, 1985.
2	Stanley E. Manahan, “Hazardous Waste Chemistry, Toxicology and Treatment”,LewisPublishers ,Chelsea, Michigan, 1990.
3	Tchobanoglous, Theisen and Vigil, “Integrated Solid Waste Management”, 2d Ed. McGraw-Hill, New York, 1993.
4	Parker Colin and Roberts, “Energy from Waste –An Evaluation of Conversion Technologies” ,Elsevier Applied Science, London, 1985.

V Semester(Open Elective-I)

Course code	Course Name	Hours/week			Credit
		L	T	P	C
ME2010003	FUNDAMENTALS OF ERGONOMICS	3	0	0	3

Objective(s)

This course provides the basic concepts of ergonomics and various tools and techniques involved in designing comfortable and safe workplace.

UNIT-I	Introducing Ergonomics:	9
Introducing Ergonomics: Fundamentals of Ergonomics / Human factors - Disciplines - Physical - Cognitive and Organizational - Needs of Ergonomics in workplace - Ergonomic Principles - Applications - Ergonomic Evaluation - Questionnaire survey.		

UNIT-II	Anthropometry:	9
Anthropometry: Human body - structure and function - Types of anthropometric data - Application of anthropometry in design - Anthropometric measuring techniques - Statistical treatment of data and percentile calculations.		
UNIT-III	**Posture and Movement:**	**9**
Posture and Movement: Biomechanical Background - Physiological Background - Sitting - Standing Change of Posture - Hand and arm postures - Movement - Lifting - Carrying - Pulling - Pushing - Repetitive motions - Rapid Upper Limb Assessment (RULA) – Rapid Entire Body Assessment (REBA) and Ovako Working Posture Assessment (OWAS) method.		
UNIT-IV	**Work Counter Behavior and Perception:**	**9**
Work Counter Behavior and Perception: Environmental issues - Physical work capacity - Factors affecting work capacity - Communication and cognitive issues - Information processing and perception - Interaction with machines - mental workload.		
UNIT-V	**Work system Evaluation and Safety:**	**9**
Work system Evaluation and Safety: Contribution of ergonomics to workstation design - Analysis of workplace design - Work envelopes - Workplace evaluation tools - case studies - Occupational / Ergonomic safety and stress at various workplace - health management rules - Scope of Ergonomics in India-case studies.		
	Total hours:	**45 periods**

Outcome

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

- Define ergonomics and its components.
- Make use of statistical treatment of data in designing the components of office and shop floor.
- Assess the common risk factors and areas for ergonomic improvement.
- Apply ergonomic principles in framing work content for workers.
- Plan the essential elements for an effective ergonomics programme.

TEXT BOOK :

1	Bridger R.S., "Introduction to Ergonomics", 3rd Edition, Taylor & Francis, New York, 2011.

REFERENCES:

1	Pamela McCauley-Bush, "Ergonomics: Foundational Principles, Applications, and Technologies", 1st Edition, Taylor & Francis, CRC Press, New York, 2011.
2	Dul J. and Weerdmeester B., "Ergonomics for beginners, a quick reference guide", 3rd Edition, Taylor & Francis, New York, 2008.

V Semester(Open Elective-I)					
Course code	**Course Name**	**Hours/week**			**Credit**
		L	**T**	**P**	**C**
ME2010004	**SAFETY MEASURES FOR ENGINEERS**	3	0	0	3

Objective(s)

The course explores the knowledge on safety aspects, procedures and guidelines to be followed in various industries, while performing various types of activities in electrical, chemical industries with appropriate personal personnel protection equipments and risk assessment procedures.

UNIT-I	Safety Management and Accident Prevention	9

Introduction: Need for Safety - Safety and Productivity - Safety Management Techniques - Job Safety Analysis - Safety Sampling Technique - Incident Recall Technique - Plant Safety Inspection - Accident: Nature and Causes of Accidents - Accident Proneness - Cost of Accident - Accident Prevention Methods - Accident Reporting and Investigation - Safety Education and Training

UNIT-II	Safety in Chemical Industry: Electrical Safety Equipments and Safety Practices	9

Voltage Measuring Instruments: Safety Voltage Measurement - Contact and Non-Contact Type Testers. Rubber Insulating Equipment: Rubber Mats - Rubber Blankets - Rubber Covers - Line Hoses and Sleeves -Inspection Techniques – Standards. Insulated Tools: Hot Sticks - Cherry Picker - Standards for Tools - Safety Barriers and Signs - Safety Tags - Lock and Locking devices. Fire Extinguishers: Fire Safety Against Electrical fire - Types of Extinguishers. Safety Earthing Practices: Distinction Between System Grounding and Equipment Grounding - Functional Requirement of Earthing Systems - Earth Electrodes - Types. Earth Mats - Procedure for Laying Earth Mat - Earth Resistance Measurements

UNIT-III	Safety in Chemical Industry:	9

Types of Chemical Industry - Statutory Provisions - Indian Standards – Types of Chemical Hazards & Controls – Material (Property) Hazards and Controls – Storage Hazards & Controls - Process Hazards & Controls - Utility Hazards & Controls - Pollution Hazards & Controls - Instrumentation for Safe Plant Operations - Safe Transfer of Chemicals - Inspection, Testing & Maintenance - Work Permits of Hazardous Work

UNIT-IV	Personnel Protection Equipment (PPE):	9

Flash and Thermal protection: Glossary of Terminologies - Flame Resistant - Arc Thermal Performance Value (ATPV) - Energy Breakthrough (EBT) - ASTM Standard for Clothing Materials - Choice of Clothing - Flame and Non-Flame Resistant Materials - Guidelines for Selection - Flash Suit Head Protection: Hard Hats – ANSI Z 89.1 Standard - Eye Protection - Requirements of Safety Glasses - Goggles - Selection - Face shield. Hearing Protection – Requirement - Ear plugs and Ear muffs - Noise Reduction Ratio - Thumb Rule. Arm and Hand Protection: Rubber Gloves - ASTM Standards - Leather Protective Glove - Level of Protection. Foot and Leg Protection and Respiratory Protection

UNIT-V	Risk Assessment and Control Techniques:	9

Risk Assessment: Basic Concepts of Risk - Safety Appraisal, Analysis and Control Techniques - Accident Investigation, Analysis and Reporting - Hazard and Risk Assessment Techniques - Reliability Engineering - Major Accident Hazard (MAH) Control - On-site and Off-site Emergency Plans

Total hours:	45 periods

Outcome

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

- Perceive the safety management concepts and accident prevention methods.
- Apply appropriate measuring and /or insulating equipment, use of fire extinguishers and safe earthing practices.
- Identify the hazards in chemical industries during transporting, storing and processing to ensure safe plant operations.
- Select the PPE based on the type of industry and standards. Iimplement the techniques like risk assessment disaster management and emergency preparedness with the proper knowledge on accident prevention

TEXT BOOK :

1	Mistry K.U., "Fundamentals of Industrial Safety and Health", 2nd Edition, Siddharth Prakashan, Ahmedabad, 2008

REFERENCES:

1	John Cadick, Mary Capelli Schellpfeffer & Dennis Neitzell, "Electrical Safety Handbook", 4th Edition, McGraw-Hill Education, 2012.
2	Davies V.J. & Thomasin K., "Construction Safety Hand Book", 2nd Edition, Thomas Telford Ltd., London, 1996.
3	Rao S, Jain R.K. & Saluja H.L., "Electrical Safety, Fire Safety Engineering and Safety

	Management", 2nd Edition, Khanna Publishers, 2012.

V Semester(Open Elective-I)					
Course code	**Course Name**	**Hours/week**			**Credit**
		L	**T**	**P**	**C**
ME2010005	**ELECTRONIC ENGINE MANAGEMENT**	3	0	0	3

Objective

- The basic concepts in electronics and engines.
- The various sensors and engine management systems used in petrol and diesel engines.

UNIT-I	**ELECTRONICS**	**9**
Semiconductors , Transistors, Amplifiers – Integrated circuits – Analog and Digital, Logic Gates, Microcontrollers –Analog Digital / Digital Analog Converters.		
UNIT-II	**SENSORS**	**9**
Sensors for Air flow, Pressure, Temperature, Speed, Exhaust Oxygen, Knock and Position sensors in engine management systems – Principle of operation, construction and characteristics.		
UNIT-III	**GASOLINE INJECTION SYSTEM**	**9**
Open loop and closed loop systems, Mono point, Multi point, Direct injection systems and Air assisted systems – Principles and Features, examples of Bosch injection systems. Idle speed, lambda, knock and spark timing control, Three way catalytic converters, Lean Nitrogen Oxide converters.		
UNIT-IV	**DIESEL INJECTION SYSTEM**	**9**
Heat release in the diesel engine and need for control of fuel injection. Inline injection pump - Rotary Pump and injector– Construction and principle of operation, Electronic control of these pumps. Common rail and unit injector system – Construction and principle of operation.		
UNIT-V	**IGNITION SYSTEMS**	**9**
Ignition fundamentals, solid state ignition systems, high energy ignition distributors, Electronic spark timing and control. Combined ignition and fuel management systems. Dwell angle calculation, Ignition timing calculation.		
	Total hours:	**45 periods**

TEXT BOOK :

1	Eric Chowaniety, “Automobile Electronics”, SAE Publications, 1995.
2	Tom Denton, “Automobile Electrical and Electronic Systems: Automotive Technology: Vehicle Maintenance and Repair”, A Butterworth-Heinemann Title, 4th Edition, 2011.

REFERENCES:

1	Duffy Smith, “Auto Fuel Systems”, The Good Heart Willcox Company Inc., Publishers, 1987.
2	Robert Bosch GmbH, “Gasoline Engine Management”, 2nd Edition, 2004.
3	Robert Bosch GmbH, “Engine Management”, 2nd Edition, 1999.
4	Eric Chowaniety, “Automobile Electronics”, SAE Publications, 1995.
5	William B. Ribbews, “Understanding Automotive Electronics”, SAE Publications, 5th Edition, 1998.

V Semester(Open Elective-I)					
Course code	**Course Name**	**Hours/week**			**Credit**
ME2010006	**FUNDAMENTALS OF MECHANICAL ENGINEERING**	**L**	**T**	**P**	**C**
		3	0	0	3

Objective

- To introduce the Mechanical Engineering discipline and its applications to society.
- Preparatory course presented in digital audio-visual, non-analytical form to inspire students to take up Mechanical Engineering as a career.
- To understand the first, second law of thermodynamics

UNIT-I	**INTRODUCTION**	**12**

Prime movers and its types, Concept of Force, Pressure, Energy, Work, Power,System, Heat, Temperature, Specific heat capacity, Change of state, Path, Process, Cycle,Internal energy, Enthalpy, Statements of Zeroth Law and First law. Energy: Introduction andapplications of Energy sources like Fossil fuels, Nuclear fuels, Hydel, Solar, wind, and bio-fuels,Environmental issues like Global warming and Ozone depletion.

UNIT-II	**PROPERTIES OF GASES AND STEAM**	**12**

Gas laws, Boyle's law, Charle's law, Combined gas law, Gas constant, Relation between Cp and Cv, Various non-flow processes like constant volume process, constant pressure process, Isothermal process, Adiabatic process, Poly-tropic process Properties of Steam: Steam formation, Types of Steam, Enthalpy, Specific volume, Internal energy and dryness fraction of steam, use of Steam tables, steam calorimeters. Steam Boilers: Introduction, Classification, Cochran, Lancashire and Babcock and Wilcox boiler, functioning of different mountings and accessories**.**

UNIT-III	**HEAT ENGINES**	**12**

Heat Engine cycle and Heat Engine, working substances, Classification of heat engines, Description and thermal efficiency of Carnot; Rankine; Otto cycle and Diesel cycles. Internal Combustion Engines: Introduction, Classification, Engine details, four- stroke/ two-stroke cycle Petrol/Diesel engines, Indicated power, Brake Power, Efficiencies.

UNIT-IV	**PUMPS**	**12**

Types and operation of Reciprocating, Rotary and Centrifugal pumps, Priming Air Compressors: Types and operation of Reciprocating and Rotary air compressors, significance of Multistage. Refrigeration & Air Conditioning: Refrigerant, Vapor compression refrigeration system, vapor absorption refrigeration system, Domestic Refrigerator, Window and split air conditioners.

UNIT-V	**TRANSMISSION AND ENGINEERING MATERIALS**	**12**

Construction and applications of Couplings (Box; Flange; Pin type flexible; Universal and Oldham), Clutches (Disc and Centrifugal), and Brakes (Block; Shoe; Band and Disc). Transmission of Motion and Power: Shaft and axle, Belt drive, Chain drive, Friction drive, Gear drive. Engineering Materials: Types and applications of Ferrous &Nonferrous metals, Timber, Abrasive material, silica, ceramics, glass, graphite, diamond, plastic and polymer.

Total hours:	**60 periods**

TEXT BOOK :

1	Basic Mechanical Engineering / Pravin Kumar/ Pearson
2	Introduction to Engineering Materials / B.K. Agrawal/ McGraw Hill
3	Thermodynamics and Heat Engines / R. Yadav / Central Book Depot
4	Thermal Engineering-M.L.Marthur& Mehta/Jain bros
5	Thermal Engineering-R.S Khurmi/JS Gupta/S.Chand.
6	Thermal Engineering-P.L.Bellaney/ Khanna publishers.
7	Elements of Environmental Science and Engineering-Meenakshi/Anjali Bagad

REFERENCES:	
1	Fundamental of Mechanical Engineering/ G.S. Sawhney/PHI
2	Thermal Science and Engineering / Dr. D.S. Kumar/ Kataria .

V Semester(Open Elective-I)					
Course code	**Course Name**	**Hours/week**			**Credit**
		L	**T**	**P**	**C**
ME2010007	**ROBOTICS**	3	0	0	3

Objective(s)

- To understand the functions of the basic components of a Robot.
- To study the use of various types of End of Effectors and Sensors
- To impart knowledge in Robot Kinematics and Programming
- To learn Robot safety issues and economics.

UNIT-I	**FUNDAMENTALS OF ROBOT**	**9**

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**	**9**

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, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

UNIT-III	**SENSORS AND MACHINE VISION**	**9**

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, Applications- Inspection, Identification, Visual Serving and Navigation.

UNIT-IV	**ROBOT KINEMATICS AND ROBOT PROGRAMMING**	**9**

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**	**9**

RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots.

Total hours:	**45 periods**

Outcome

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

- explain the concepts of industrial robots, classification, specifications and coordinate systems. Also summarize the need and application of robots in different sectors.
- illustrate the different types of robot drive systems as well as robot end effectors.
- apply the different sensors and image processing techniques in robotics to improve the ability of robots.
- develop robotic programs for different tasks and familiarize with the kinematics motions of robot.
- examine the implementation of robots in various industrial sectors and interpolate the economic analysis of robots.

TEXT BOOK :

1	Groover M.P., "Industrial Robotics -Technology Programming and Applications", McGraw Hill, 2012.
2	Klafter R.D., Chmielewski T.A and Negin M., "Robotic Engineering - An Integrated Approach",Prentice Hall, 2003.

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., 2013.
3	Fu.K.S.,Gonzalz R.C. and Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill Book Co., 1987.
4	Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill, 1995.
5	Koren Y., "Robotics for Engineers", Mc Graw Hill Book Co., 1992.