B.E. MECHANICAL ENGINEERING

CURRICULUM

(2019 AND ONWARDS)

(PART TIME PROGRAMME)

Department of Mechanical Engineering
FACULTY OF ENGINEERING

Enable | Enlighten | Enrich
KARPAGAM
ACADEMY OF HIGHER EDUCATION
(Deemed to be University)
(Established Under Section 3 of UGC Act, 1956)

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Pollachi Main Road, Eachanari Post, Coimbatore – 641 021. INDIA

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(Deemed to be University Established Under Section 3 of UGC Act, 1956)
Eachanari Post, Coimbatore-641021.Tamilnadu,India.

FACULTY OF ENGINEERING

B.E. (MECHANICAL ENGINEERING – PART TIME)

COURSE OF STUDY AND SCHEME OF EXAMINATION

(2019 Batch Onwards)

SEMESTER I										
Course Code	**Course title**	**Objectives & Outcomes**		**Instruction Hours / Week**			**Credits**	**Maximum Marks**		
		PEO	**PO**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**
								40	**60**	**100**
THEORY										
19PBEME101	Engineering Mathematics I	1	1,2,3,4	3	1	0	4	40	60	100
19PBEME102	Engineering Mechanics	1	1,2,3,4, 10,11	3	0	0	3	40	60	100
19PBEME103	Basic Electrical and Electronics Engineering	1	1,2,3,4, 7,11	3	0	0	3	40	60	100
19PBEME104	Manufacturing Technology	1	1,2,3,6, 8,9	3	0	0	3	40	60	100
PRACTICAL										
19PBEME111	Computer Aided Design Laboratory	1	1,2,3,4, 5,8,9	0	0	3	2	40	60	100
			Total	12	1	3	15	200	300	500

SEMESTER II										
Course Code	**Course title**	**Objectives & Outcomes**		**Instruction Hours / Week**			**Credits**	**Maximum Marks**		
		PEO	**PO**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**
								40	**60**	**100**
THEORY										
19PBEME201	Engineering Mathematics II	1	1,2,3,4	3	1	0	4	40	60	100
19PBEME202	Strength of Materials	1	1,2,3,4, 10	3	0	0	3	40	60	100
19PBEME203	Theory of Machines	1	1,2,3,4, 10	3	0	0	3	40	60	100
19PBEME204	Fundamentals of Computer Programming	1,2	1,2,3,5, 9,10	3	0	0	3	40	60	100
PRACTICAL										
19PBEME211	Strength of Materials Laboratory	1	1,2,3,4, 10	0	0	3	2	40	60	100
			Total	12	1	3	15	200	300	500

SEMESTER III										
Course Code	**Course title**	**Objectives & Outcomes**		**Instruction Hours / Week**			**Credits**	**Maximum Marks**		
		PEO	**PO**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**
								40	**60**	**100**
THEORY										
19PBEME301	Thermodynamics	1	1,2,3,4,10	3	1	0	4	40	60	100
19PBEME302	Engineering Materials and Metallurgy	1	1,2,3,4,10	3	0	0	3	40	60	100
19PBEME303	Industrial Metrology	1	1,2,3,4,10	3	0	0	3	40	60	100
19PBEME304	Fluid Mechanics & Fluid Machines	1	1,2,3,4,10	3	0	0	3	40	60	100
PRACTICAL										
19PBEME311	Fluid Mechanics and Metrology Laboratory	1	1,2,3,4,10	0	0	3	2	40	60	100
			Total	12	1	3	15	200	300	500

SEMESTER IV										
Course Code	**Course title**	**Objectives & Outcomes**		**Instruction Hours / Week**			**Credits**	**Maximum Marks**		
		PEO	**PO**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**
								40	**60**	**100**
THEORY										
19PBEME401	Applied Thermodynamics	1	1,2,3,4,10	3	1	0	4	40	60	100
19PBEME402	Design of Mechatronic Systems	1,2	1,2,3,5,9,10	3	0	0	3	40	60	100
19PBEME403	Design of Machine Elements	1	1,2,3,4,9	3	0	0	3	40	60	100
19PBEME404	Environmental Science	1	1,2,6,7,8,9,10	3	0	0	3	40	60	100
PRACTICAL										
19PBEME411	Thermal Engineering Laboratory	1	1,2,3,4,10	0	0	3	2	40	60	100
			Total	12	1	3	15	200	300	500

SEMESTER V										
Course Code	**Course title**	**Objectives & Outcomes**		**Instruction Hours / Week**			**Credits**	**Maximum Marks**		
		PEO	**PO**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**
								40	**60**	**100**
THEORY										
19PBEME501	Heat and Mass Transfer	1	1,2,3,4,5	3	1	0	4	40	60	100
19PBEME502	Operations Research	1,3	1,4,7,8,11	3	0	0	3	40	60	100
19PBEME503	Design of Transmission Systems	1	1,2,3,4,8, 9,10	3	0	0	3	40	60	100
19PBEME5E-	Professional Elective - I	-	-	3	0	0	3	40	60	100
PRACTICAL										
19PBEME511	Computer Aided Manufacturing Laboratory	1	1,2,3,4,5, 8,9	0	0	3	2	40	60	100
			Total	12	1	3	15	200	300	500

SEMESTER VI										
Course Code	**Course title**	**Objectives & Outcomes**		**Instruction Hours / Week**			**Credits**	**Maximum Marks**		
		PEO	**PO**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**
								40	**60**	**100**
THEORY										
19PBEME601	Engineering Economics and Financial Management	1,3	1,2,6,7,8, 9,12	3	0	0	3	40	60	100
19PBEME602	Automation in Manufacturing	1	1,2,3,4,5, 8,9	3	0	0	3	40	60	100
19PBEME6E-	Professional Elective - II	-	-	3	0	0	3	40	60	100
19PBEME6E-	Professional Elective - III	-	-	3	0	0	3	40	60	100
PRACTICAL										
19PBEME611	Computer Aided Analysis Laboratory	1	1,2,3,4,5, 8,9	0	0	3	2	40	60	100
			Total	12	0	3	14	200	300	500

SEMESTER VII										
Course Code	**Course title**	**Objectives & Outcomes**		**Instruction Hours / Week**			**Credits**	**Maximum Marks**		
		PEO	**PO**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**
								40	**60**	**100**
THEORY										
19PBEME701	Total Quality Management	1,3	1,2,6,7, 8,9,12	3	0	0	3	40	60	100
19PBEME7E-	Professional Elective - IV	-	-	3	0	0	3	40	60	100
19PBEME7E-	Professional Elective - V	-	-	3	0	0	3	40	60	100
PRACTICAL										
19PBEME791	Project Work and Viva Voce	1,2,3	1,2,3,4, 5,6,7,8, 9,10,11, 12	0	0	9	6	40	60	100
			Total	9	0	9	15	160	240	400

PROFESSIONAL ELECTIVE I										
Course Code	**Course title**	**Objectives & Outcomes**		**Instruction Hours / Week**			**Credits**	**Maximum Marks**		
		PEO	**PO**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**
								40	**60**	**100**
19PBEME5E01	Emerging Materials	1	1,2,3,4, 10	3	0	0	3	40	60	100
19PBEME5E02	Renewable Energy Sources	1	1,2,3,4, 6,7,9	3	0	0	3	40	60	100
19PBEME5E03	Advanced I.C. Engines	1	1,2,3,4, 6,7,9	3	0	0	3	40	60	100
19PBEME5E04	Hydraulics and Pneumatics Power Control	1	1,2,3,4, 9,11,12	3	0	0	3	40	60	100
19PBEME5E05	Automobile Engineering	1	1,2,3,4, 6,7,9	3	0	0	3	40	60	100

PROFESSIONAL ELECTIVE II										
Course Code	**Course title**	**Objectives & Outcomes**		**Instruction Hours / Week**			**Credits**	**Maximum Marks**		
		PEO	**PO**	**L**	**T**	**P**		**CIA**	**ESE**	**Total**
								40	**60**	**100**
19PBEME6E01	Design of Jigs, Fixtures and Press Tools	1	1,2,3,4, 6,7,9	3	0	0	3	40	60	100
19PBEME6E02	Refrigeration and Air Conditioning	1	1,2,3,4, 8	3	0	0	3	40	60	100
19PBEME6E03	Advanced Manufacturing Processes	1	1,2,3,4, 9,12	3	0	0	3	40	60	100
19PBEME6E04	Design and Analysis of Experiments	1	1,2,34,5 ,9	3	0	0	3	40	60	100
19PBEME6E05	Hybrid Vehicle Technology	1	1,2,3,4, 5,9	3	0	0	3	40	60	100

PROFESSIONAL ELECTIVE III										
Course Code	Course title	Objectives & Outcomes		Instruction Hours / Week			Credits	Maximum Marks		
		PEO	PO	L	T	P		CIA	ESE	Total
								40	60	100
19PBEME6E06	Design for Manufacture and Assembly	1	1,2,3,5,6,8,9	3	0	0	3	40	60	100
19PBEME6E07	Computational Fluid Dynamics	1	1,2,3,4,5,9	3	0	0	3	40	60	100
19PBEME6E08	Power Plant Engineering	1	2,3,4,6	3	0	0	3	40	60	100
19PBEME6E09	Additive Manufacturing	1	1,2,3,4,9,12	3	0	0	3	40	60	100
19PBEME6E10	Logistics & Supply Chain Management	1,3	1,2,6,7,8,9,12	3	0	0	3	40	60	100

PROFESSIONAL ELECTIVE IV										
Course Code	Course title	Objectives & Outcomes		Instruction Hours / Week			Credits	Maximum Marks		
		PEO	PO	L	T	P		CIA	ESE	Total
								40	60	100
19PBEME7E01	Gas Dynamics and Jet Propulsion	1	1,2,3,4,10,12	3	0	0	3	40	60	100
19PBEME7E02	Production Planning and Control	1,3	1,2,3,5,7,8,9,11	3	0	0	3	40	60	100
19PBEME7E03	Machine Tool Design	1	1,2,3,5,6,8,9	3	0	0	3	40	60	100
19PBEME7E04	Computer Integrated Manufacturing	1,2	5,9,11	3	0	0	3	40	60	100
19PBEME7E05	Advanced Welding Technology	1	1,2,3,4,6,7,9	3	0	0	3	40	60	100

PROFESSIONAL ELECTIVE V										
Course Code	Course title	Objectives & Outcomes		Instruction Hours / Week			Credits	Maximum Marks		
		PEO	PO	L	T	P		CIA	ESE	Total
								40	60	100
19PBEME7E06	Composite Materials	1	1,2,3,5,6,8,9	3	0	0	3	40	60	100
19PBEME7E07	Quality Control and Reliability Engineering	1,3	1,3,4,7,9,11	3	0	0	3	40	60	100
19PBEME7E08	Non Destructive Testing	1	1,2,3,4,6,7,8,9,10	3	0	0	3	40	60	100
19PBEME7E09	Industrial Safety Engineering	1,3	1,2,3,4,6,7,8,9,10	3	0	0	3	40	60	100
19PBEME7E10	Industrial Robotics	1	1,2,3,4,6,7,9	3	0	0	3	40	60	100

Total number of credits: 104

L: Lecture Hour **T: Tutorial Hour** **CIA: Continuous Internal Assessment**

P: Practical Hour **C: No. of Credits** **ESE: End Semester Examinations**

19PBEME101 ENGINEERING MATHEMATICS – I SEMESTER – I
4H: 4C

Instruction Hours / Week: - L: 3 T: 1 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

The objective of this course is

1. To familiarize the prospective engineers with techniques in calculus, and multivariate analysis.
2. To familiarize the prospective engineers with techniques in linear algebra.
3. To equip the students with standard concepts and tools at an intermediate to advanced level.
4. To equip the students will serve them towardstackling more advanced level of mathematics.
5. To make the students will serve them to find the useful applications in their disciplines.
6. To make the students to solve the real time problems using standard concepts and tools.

COURSE OUTCOMES

The students will learn:

1. To apply differential and integral calculus to notions of curvature and to improperintegrals.
2. Apart from some other applications they will have a basic understanding of Beta and Gammafunctions.
3. The tool of power series and Fourier series for learning advanced EngineeringMathematics.
4. To deal with functions of several variables thatare essential in most branches ofengineering.
5. The essential tool of matrices and linear algebra in a comprehensivemanner.
6. Students can solve real time problems using standard concepts and tools.

1. .

UNIT I MATRICES 9+3

Review of Matrix Algebra - Characteristic equation – Eigenvalues and Eigenvectors of a real matrix – Properties – Cayley-Hamilton theorem (excluding proof) – Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic forms – Reduction to canonical form through orthogonal reduction.

UNIT II DIFFERENTIAL CALCULUS 9+3

Overview of Derivatives - Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes – Envelopes

UNIT III DIFFERENTIAL EQUATIONS 9+3

Introduction to Ordinary differential equations: linear ordinary differential equations of second and higher order with constant coefficients.

Introduction to Partial differential equations– Linear partial differential equations of second and higher order with constant coefficients

UNIT IV ANALYTIC FUNCTIONS 9+3

Analytic functions – Necessary and Sufficient conditions for an analytic function (Without proof) Cauchy-Riemann equations –Harmonic-Properties of analytic functions- Constructions of an analytic function - Conformal mapping: w = z+a, az, 1/z and bilinear transformation

UNIT V Z -TRANSFORM AND DIFFERENCE EQUATIONS 9+3

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

TOTAL 45 + 15 = 60 PERIODS

SUGGESTED READINGS

1. Hemamalini. P.T, Engineering Mathematics, McGraw Hill Education (India) Private Limited, New Delhi, 2014
2. Sundaram, V. Lakhminarayan,K.A. & Balasubramanian,R., Engineering Mathematics for first year, Vikas Publishing Home , New Delhi, 2006
3. Grewel . B. S., Higher Engineering Mathematics, Khanna Publications, New Delhi, 2016
4. Bhaskar Rao. P. B, Sri Ramachary SKVS, Bhujanga Rao. M (2010), Engineering Mathematics I, BS Publications, India, 2010
5. Ramana. B.V , Higher Engineering Mathematics, Tata McGraw Hill Publishing Company, New Delhi, 2017
6. Shahnaz Bathul , Text book of Engineering Mathematics(Special Functions and Complex Variables), PHI Publications, New Delhi, 2009
7. Michael D. Greenberg , Advanced Engineering Mathematics, Pearson Education, India, 2009

19PBEME102 ENGINEERING MECHANICS SEMESTER – I
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To develop capacity to predict the effect of force and motion.
2. To understand the importance of free body diagram for complex machine structure.
3. To perform force analysis using law of mechanics.
4. To introduce the concepts of static equilibrium condition for particles and rigid bodies
5. To Understand the concepts of kinematics of particles and friction.
6. To make the students conversant to solve the problems using equation of motions.

COURSE OUTCOMES

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

1. Understand the basic concepts of force and laws of mechanics.
2. Develop free body diagram for complex machine structure and to perform force analysis.
3. Apply static equilibrium condition for particles and rigid bodies.
4. Locate the center of gravity and moment of inertia for planes and solids.
5. Understand the concepts of kinematics of particles and friction.
6. Solve the problems using equation of motions.

UNIT I STATICS OF PARTICLES 9

Forces – system of forces – concurrent forces in plane and space– resultant – problems involving the equilibrium of a particle–free body diagram–equilibrium of particle in space.

UNIT II STATICS OF RIGID BODIES IN TWO DIMENSIONS 9

Rigid bodies–moment of force about an axis–moments and couples–equivalent system of coplanar forces–Rigid body in equilibrium–problems involving equilibrium of rigid body–types of supports–reactions of beams.

UNIT III CENTROID, CENTRE OF GRAVITY AND MOMENT OF INERTIA 9

Centroids of areas, composite areas, determination of moment of inertia of plane figures, polar moment of inertia – radius of gyration – mass moment of inertia of simple solids.

UNIT IV KINEMATICS OF PARTICLES 9

Introduction – plane, rectilinear motion – time dependent motion – rectangular coordinates – projectile motion.

IMPULSE AND MOMENTUM: Concept of conservation of momentum – Impulse–Momentum principle– Impact – Direct central impact – Oblique central impact – Impact of elastic bodies.

UNIT V KINETICS OF PARTICLES AND FRICTION 9

KINETICS OF PARTICLES: Equations of motion–rectilinear motion–Newton's II law – D'Alembert's principle – Energy – potential energy–kinetic energy–conservation of energy–work done by a force – work energy method.

Laws of friction – coefficient of friction–problems involving dry friction – wedge and ladder friction.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Beer F P and Johnson E.R, Vector Mechanics for Engineers–Statics and Dynamics, Tata Mc–Graw Hill Publishing Co. Ltd., New Delhi, 2015
2. Rajasekaran.S and Sankarasubramanian G, Engineering Mechanics–Statics and Dynamics, Vikas Publishing House Pvt. Ltd., New Delhi, 2011
3. Bansal R K, Engineering Mechanics, Laxmi Publications Pvt. Ltd., New Delhi, 2015
4. Young D H and Timashenko S, Engineering Mechanics, Tata McGraw–Hill, New Delhi, 2013
5. Jivan Khachane and Ruchi Shrivastava, Engineering Mechanics: Statics and Dynamics, ANE Books, New Delhi, 2013

19PBEME103 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING SEMESTER – I 3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To provide an overview of various analogdevice
2. To provide an overview of Digitalconcepts
3. To learn working of amplifier and its application.
4. To understand the concept of RC-timing circuits.
5. To learn cellular concept and block diagram of GSM system.
6. To provide a review of communicationsystem

COURSE OUTCOMES

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

1. Understand the principles of semiconductor devices and theirapplications.
2. Understand the concept of voltageregulators
3. Design an application using Operationalamplifier.
4. Understand the working of timing circuits andoscillators.
5. Understand logic gates, flip flop as a building block of digitalsystems.
6. Learn the basics of Electronic communicationsystem.

UNIT I ELECTRIC CIRCUITS & MEASUREMENTS 9

Ohm's Law – Kirchoff's Laws – Steady State Solution of DC Circuits – Introduction to AC Circuits Waveforms and RMS Value – Power and Power factor – Single Phase and Three Phase balanced Circuits.

UNIT II ELECTRICAL MACHINES 9

Construction, Principle of Operation, Basic Equations and Applications of DC Generators, DC Motors, Single Phase Transformer, single phase induction Motor.

UNIT III MEASURING INSTRUMENTS 9

Operating Principles of Moving Coil and Moving Iron Instruments (Ammeters and Voltmeters), Dynamometer type Watt meters and Energy meters.

UNIT IV SEMICONDUCTOR DEVICES AND APPLICATIONS 9

Characteristics of PN Junction Diode – Zener Effect – Zener Diode and its Characteristics – Half wave and Full wave Rectifiers – Voltage Regulation. Bipolar Junction Transistor – CB, CE, CC Configurations and Characteristics

UNIT V DIGITAL ELECTRONICS 9

Binary Number System – Logic Gates – Boolean Algebra – Half and Full Adders – Flip-Flops – Registers and Counters – A/D and D/A Conversion (single concepts).

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Mittle, V.M , Basic Electrical Engineering, Tata McGraw Hill Edition, New Delhi, 2005
2. Sedha R.S, Applied Electronics, S. Chand & Co, 2013
3. Muthusubramanian R, and Muraleedharan K A , Basic Electrical, Electronics and Computer Engineering, Tata McGraw Hill, Second Edition, 2006
4. Nagsarkar T K and Sukhija M S, Basics of Electrical Engineering, Oxford press, 2011
5. Mahmood Nahvi and Joseph A. Edminister, Electric Circuits, Schaum' Outline Series, McGraw Hill, 2014
6. Premkumar N, Basic Electrical Engineering, Anuradha Publishers, 2014

19PBEME104 MANUFACTURING TECHNOLOGY SEMESTER – I
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To familiarize the students to apply suitable molding and casting methods for producing components.
2. To develop anunderstanding of types of metal joining processes.
3. To explain types of deformation processes.
4. To understand the concept of sheet metal operations and metal forming processes.
5. To provide an overview ofvarious plastic component manufacturing processes for various applications.
6. To Study and acquire knowledgeof process variables to manufacture defect free products.

COURSE OUTCOMES

Upon completion of this course, the students can able to

1. Apply suitable molding and casting methods for producing components.
2. Decide the type of metal joining processes.
3. Select the type of deformation processes.
4. Work with various sheet metal operations and metal forming processes.
5. Select the various plastic component manufacturing processes for various applications.
6. Identify the effect of process variables to manufacture defect free products.

UNIT I FOUNDRY EQUIPMENTS AND MATERIALS 8

Patterns. Moulds-types of moulds, moulding sand characteristics and testing procedures. Core making, melting furnaces.

UNIT II PRODUCTION OF CASTINGS 8

Processes-shell moulding, investment castings, centrifugal castings, die casting. Gating and risering. Fettling and cleaning of casting. Inspection and testing of castings. Casting defects and remedies.

UNIT III WELDING 9

GAS WELDING -Oxy-acetylene welding, types of flames, welding torches, welding techniques. ARC WELDING-carbon arc, shielded metal arc, submerged arc, TIG and MIG welding. Welding electrodes-function and characteristics of electrode coating. RESISTANCE WELDING-spot, seam, projection and butt welding, heat flow in welded components. Other welding process, Laser beam welding, Electron beam welding. Friction welding, Friction stir welding and Ultra sonic welding.

UNIT IV METAL FORMING PROCESSES 9

Cold and hot working, rolling, drawing, extrusion and forging, sheet metal cutting, bending. Drawing applications, defects. Types of presses.

UNIT V SPECIAL FORMING METHODS 8

Explosive forming, electro magnetic forming, electro hydraulic forming, powder metallurgy process, composite mouldings.

INTRODUCTION TO SOFTWARE FOR MANUFACTURING APPLICATIONS *(Not for exam)* **3**

Metal forming and flow analysis software (for metallic /plastic components).

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Serope Kalpajian, Steven R.Schmid, Manufacturing Engineering and Technology, 4e, Pearson Education, Inc., New Delhi, 2014
2. D. K. Singh, Manufacturing Technology, 2e, Pearson Education, Inc., New Delhi, 2008
3. P.N. Rao, Manufacturing Technology: Vol I, 4e, Tata McGraw–Hill Publishing Limited, New Delhi, 2013
4. P.C. Sharma, A text book of production technology Fourth Edition, S. Chand and Company, New Delhi, 2014
5. Phillip F. Ostwald, Jairo Munoz, Manufacturing Processes and Systems, 9ed, John Wiley and Sons, 2005

19PBEME111 COMPUTER AIDED DESIGN LABORATORY SEMESTER – I
3H: 2C

Instruction Hours / Week: - L: 0 T: 0 P: 3 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To gain practical experience in handling 2D drafting and 3D modeling software systems.
2. To impart training on SOLID WORKS for modelling
3. To provide knowledge on assembly of components
4. To facilitate the understanding of manufacturing drawings from the models created
5. To equip them with skills to Construct an assembly drawing using part drawings of machine components.
6. To equip them with skills to Construct an assembly drawing of machine components using 2D drafting.

COURSE OUTCOMES

Upon completion of this course, the students can able to

1. use computer and CAD software's for modeling of mechanical components
2. use various options in Solid Works for modeling of given components
3. create assembly of components
4. Make part drawings from an assembly drawing.
5. Interpret the details of complex parts in cross section views.
6. Sketch production drawing from assembly drawing.

COMPUTER AIDED DESIGN

1. 3D modeling of various machine elements using various options like protrusion, cut, sweep, draft, loft, blend, rib.
2. Assembly – creating assembly from parts – assembly constraints
3. Conversion of 3D solid model to 2D drawing – different views, sections, isometric view and dimensioning.
4. Introduction to Surface Modeling.
5. Introduction to File Import, Export – DXF, IGES, STL, STEP

Note: Any one of the 3D MODELING software's like SOLIDWORKS, CREO, CATIA, NX Software, AutoCAD etc.

TOTAL 45 PERIODS

19PBEME201 ENGINEERING MATHEMATICS – II SEMESTER – II
4H: 4C

Instruction Hours / Week: - L: 3 T: 1 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

The objective of this course is

1. To familiarize the prospective engineers with techniques in Multivariate integration.
2. To familiarize the concept of ordinary and partial differential equations and complex variables.
3. To equip the students to deal with advanced level of mathematics and applications.
4. To make the students to formulate and solve problems involving random variables.
5. To equip the students to Understand the basic concepts of one- and two-dimensional random variables.
6. To understand the concept of testing of hypothesis for small and large samples in real life problems.

COURSE OUTCOMES

The students will learn:

1. The mathematical tools needed in evaluating multiple integrals and their usage.
2. The effective mathematical tools for the solutions of differential equations that model physical processes.
3. The tools of differentiation and integration of functions of a complex variable that are used in various techniques dealing engineering Problems.
4. Understand the basic concepts of one- and two-dimensional random variables and apply in engineering applications.
5. They can also formulate and solve problems involving random variables and apply statistical methods for analyzing experimental data
6. Apply the concept of testing of hypothesis for small and large samples in real life problems.

UNIT I MULTIPLE INTEGRALS 9+3

Double integration – Cartesian coordinates – Polar coordinates – Change of order of integration – Triple integration in Cartesian co-ordinates – Area as double integrals.

UNIT II VECTOR CALCULUS 9+3

Gradient, Divergence and Curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector integration - Green's theorem, Gauss divergence theorem and Stoke's theorems (Statement only)- Surfaces : hemisphere and rectangular parallelepipeds

UNIT III FOURIER SERIES 9+3

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 IV APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9+3

Classification of second order quasi linear partial differential equations – Solutions of one dimensional wave equation – One dimensional heat equation – Steady state solution of two-dimensional heat equation (Insulated edges excluded).

UNIT V LAPLACE TRANSFORMS 9+3

Transforms of elementary functions – Basic properties – Transforms of derivatives and integrals – Initial and final value theorems. Inverse Laplace transforms – Convolution theorem – Solution of Ordinary Differential Equations with constant coefficients using Laplace transforms – Transform of periodic functions

TOTAL 45 + 15 = 60 PERIODS

SUGGESTED READINGS

1. Hemamalini. P.T , Engineering Mathematics I & II, McGraw-Hill Education Pvt.Ltd, New Delhi, 2014
2. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, Delhi, 2014
3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons. Singapore, 2011
4. Kandasamy. P, Thilagavathy. K, Engineering Mathematics, S Chand and Co. Ltd, New Delhi, 2008
5. Venkataraman, M. K., Engineering Mathematics, The National Publishing Company, Chennai, 2005
6. Narayanan. S, and Ramaniah.G, Advanced Mathematics for Engineering Students, Viswanathan S.(Printers and Publishers) Pvt. Ltd. Chennai, 2002

19PBEME202 STRENGTH OF MATERIALS SEMESTER – II
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To understand the concepts of stress and strain on deformation of solids.
2. To introduce the Concepts of safe working stresses and load carrying capacity of beams.
3. To enrich the understanding of deflection in beams and columns in engineering applications.
4. To understand the importance of the effect of torsion on shafts and springs.
5. To provide knowledge on principal stresses and analyze thin cylinders and shells subjected to pressure forces.
6. To provide knowledge on components subjected to various loadings with the help of various theories of failures.

COURSE OUTCOMES

Upon completion of this course, the students can able to

1. Determine stress and strain on deformation of solids.
2. Compute safe working stresses and load carrying capacity of beams.
3. Estimate the deflection in beams and columns in engineering applications.
4. Analyzethe effect of torsion on shafts and springs.
5. Determine principal stresses and analyze thin cylinders and shells subjected to pressure forces.
6. Designthe components subjected to various loadings with the help of various theories of failures.

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Rigid and Deformable bodies – Strength, Stiffness and Stability – Stresses; Tensile, Compressive and Shear – Deformation of simple and compound bars under axial load – Thermal stress – Elastic constants – Strain energy and unit strain energy – Strain energy in uniaxial loads.

UNIT II BEAMS – LOADS AND STRESSES 9

Types of beams: Supports and Loads – Shear force and Bending Moment in beams – Cantilever, Simply supported and Overhanging beams – Relationship between load, shear force and bending moment – Stresses in beams – Theory of simple bending – Stress variation along the length and in the beam section – Effect of shape of beam section on stress induced – Shear stresses in beams – Shear flow.

UNIT III BEAM DEFLECTION 9

Elastic curve of Neutral axis of the beam under normal loads – Evaluation of beam deflection and slope: Macaulay Method – Columns – End conditions – Equivalent length of a column – Euler equation – Slenderness ratio – Rankine's formula for columns

UNIT IV TORSION 9

Analysis of torsion of circular bars – Torsional Shear stress – Bars of solid and hollow circular section – Stepped shaft – Torsional rigidity – Compound shafts – Fixed and simply supported shafts – Application to close–coiled helical springs – Maximum shear stress in spring section including Wahl Factor – Deflection of helical coil springs under axial loads – Design of helical coil springs – stresses in helical coil springs under torsion loads

UNIT V ANALYSIS OF STRESSES IN TWO DIMENSIONS 9

Biaxial state of stresses – Thin cylindrical and spherical shells – Deformation in thin cylindrical and spherical shells – Biaxial stresses at a point – Stresses on inclined plane – Principal planes and stresses – Mohr's circle for biaxial stresses – Maximum shear stress – Strain energy in bending and torsion.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Punmia B.C and Jain A.K, Strength of Materials and Theory of Structures – Vol.1, Laxmi Publications New Delhi, 2015
2. Ramamrutham S and Narayan R, Strength of Materials, Dhanpat Rai and Sons., New Delhi, 2008
3. Jindal U C, Textbook on Strength of Materials, Asian Books Pvt, Ltd, Chennai, 2012
4. Don H Morris, and Leroy D Sturges, Mechanics of Materials, John Wiley and Sons Inc, 2006
5. Bedi D S, Strength of Materials, S Chand and Co. Ltd., New Delhi, 1984

19PBEME203 THEORY OF MACHINES SEMESTER – II
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. 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 and cam mechanisms for specified output motions.
2. 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.
3. To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms.
4. To understand the undesirable effects of unbalances resulting from prescribed motions in mechanism.
5. To expose students to vibration phenomenon and its types along with the vibration terminologies.
6. To understand the effect of Dynamics of undesirable vibrations.

COURSE OUTCOMES

Upon completion of this course, the students can able to

1. Identify the type and mechanism and will be able to perform velocity and acceleration analysis
2. Classify the types of friction and understand the friction applications used in screw threads, clutches, brakes.
3. Specify the gear terminology and to select appropriate gear trains for engineering applications.
4. Perform force analysis of reciprocating engine and balancing of rotating & reciprocating masses.
5. Describe the vibration phenomenon and its types along with the vibration terminologies.
6. Analyze the systems subjected to vibration

UNIT I MECHANISMS 9

Machine Structure – Kinematic link, pair and chain – Grueblers criteria – Constrained motion – Degrees of freedom - Slider crank and crank rocker mechanisms – Inversions – Applications – Displacement, velocity and acceleration – analysis in simple mechanisms – Graphical Method –velocity and acceleration polygons.

UNIT II KINEMATICS 9

Surface contacts–Sliding and Rolling friction – Friction drives – Friction in screw threads – Friction clutches – Belt and rope drives, Friction aspects in Brakes.

UNIT III KINEMATICS OF CAM 9

Gear profile and geometry – Nomenclature of spur and helical gears – Gear trains: Simple, compound gear trains and epicylic gear trains - Determination of speed and torque- Cams – Types of cams – Design of profiles – Knife edged, flat faced and roller ended followers with and without offsets for various types of follower motions.

UNIT IV GEARS 9

Dynamic force analysis- Inertia force and Inertia torque – D'Alemberts principle – The principle of superposition – Dynamic Analysis in Reciprocating Engines - Static and dynamic balancing – Balancing of rotating masses – Balancing a single cylinder Engine – Balancing Multi–cylinder Engines.

UNIT V FRICTION IN DRIVES 9

Free vibration – Equations of motion – natural frequency – Damping Types of Damping – Damped vibration, critical speeds of simple shaft. Response to periodic forcing – Harmonic Forcing – Forcing caused by unbalance – Support motion – Force transmissibility and amplitude transmissibility – Vibration isolation. Torsional systems; Natural frequency of free torsional vibrations, Natural frequency of two and three rotor systems.

. TOTAL 45 PERIODS

SUGGESTED READINGS

1. Rattan S.S, Theory of Machines, 4e, Tata McGraw–Hill Publishing Company Ltd., New Delhi, 2014
2. Shigley J.E, Uicker J.J, Theory of Machines and Mechanisms, 10e, McGraw–Hill, New York, 2014
3. Rao J.S., Dukkipati R.V, Mechanism and Machine Theory, New Age International publishers, 2007
4. Charles E. Wilson, Kinematics and Dynamics of Machinery, 3/e, Pearson Education Ltd, 2008
5. Thomas Bevan, Theory of Machines, 3e, CBS Publishers and Distributors, New Delhi, 2005
6.

19PBEME204 FUNDAMENTALS OF COMPUTER PROGRAMMING SEMESTER – II 3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To have knowledge on computer hardwares and softwares
2. To understand the various data representation techniques
3. To make the students to get knowledge on software engineering methodologies
4. To know the correct and efficient ways of solving problems
5. To learn to develop algorithm for simple problem solving
6. To learn to program in C

COURSE OUTCOMES

At the end of the course, the student will understand the software

1. To formulate simple algorithms for arithmetic and logical problem.
2. To translate the algorithms to programs (in C language
3. To test and execute the programs and correct syntax and logical error
4. To implement conditional branching, iteration and recursion
5. To decompose a problem into functions and synthesize a complete program using divide and conquer approach
6. To use arrays, pointers and structures to formulate algorithms and programs

UNIT I COMPUTER BASICS 9

Evolution of computers- Generations of computers- Classification of computers-Applications of computers- Computer Organization and Architecture- Computer Memory and Storage- Input Output Devices

UNIT II SOFTWARE, PROGRAMMING AND INTERNET 9

Algorithm- Flowchart- Pseudo code – Program control structures- Programming paradigms- Programming languages- Generations of Programming languages- Computer Software- Definition- Categories of Software - Internet- Evolution- Basic Internet terms- Internet-Applications

UNIT III C FUNDAMENTALS 9

Introduction to C- Constants- Variables- Data types- Operators and Expressions-Managing Input and Output operations- Decision Making and Branching- Looping

UNIT IV ARRAYS AND FUNCTIONS 9

Arrays- Character Arrays and Strings- User defined functions- Storage Classes

UNIT V STRUCTURES AND FILES 9

Structures- Definition- Initialization- Array of Structures- Structures within structures- Structures and Functions- Unions- File Management in C

TOTAL 45 PERIODS

SUGGESTED READINGS

1. E. Balagurusamy, Computing Fundamentals and C Programming, Mcgraw Higher Ed, 2017
2. ITL Education Solutions Ltd, Introduction to Information Technology, Pearson Education. Delhi, 2008
3. Rajaraman, V, Fundamentals of Computers. IV Edition, Prentice Hall, New Delhi, 2006
4. Byron Gottfried, Programming with C Second Edition, TMH, New Delhi, 2002

19PBEME211 STRENGTH OF MATERIALS LABORATORY SEMESTER – II
3H: 2C

Instruction Hours / Week: - L: 0 T: 0 P: 3 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To perform different destructive testing
2. To learn the characteristic materials
3. To understand the stress and strain relationship.
4. To determine the shear force for various materials.
5. To determine the impact load for various materials.
6. To determine the hardness for various materials

COURSE OUTCOMES

1. Ability to perform different destructive testing
2. Ability to characteristic materials
3. Understand the stress and strain relationship.
4. Determine the shear force for various materials.
5. Determine the impact load for various materials.
6. Determine the hardness for various materials

LIST OF EXPERIMENTS

1. Tensile test on metals–stress strain characteristics
2. Cupping test on metal sheets–load deformation characteristics, cupping load, cupping number.
3. Hardness test on metals–Brinell, Vicker and Rockwell Hardness tests.
4. Impact test on metals–Charpy, Izod impact tests.
5. Shear test on metals–direct shear strength, single shear, double shear.
6. Tests on helical springs–compression, tension springs–load deformation characteristics, stiffness, shear stress, modulus of rigidity, energy.
7. Torsion test on beams–torque and angle of twist characteristics, shear stress, modulus of rigidity, energy.

TOTAL 45 PERIODS

19PBEME301 THERMODYNAMICS SEMESTER – III
4H: 4C

Instruction Hours / Week: - L: 3 T: 1 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To understand theModel of physical systems into relevant thermodynamic system and apply energy balance equation for closed and open system.
2. To provide knowledge on entropy change in thermodynamic processes.
3. To Study and acquire knowledge on various thermodynamic properties of pure substances in real time problems.
4. To establish the basic thermodynamic relations and properties of ideal and real gases for physical systems.
5. To facilitate the understanding of properties of air using psychometric chart.
6. To acquaint the student with the conceptsand applications of the thermodynamics to the various real-life systems.

COURSE OUTCOMES

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

1. Understand the first law and able to differentiate closed and open system, also able to apply first law to both types of systems
2. Define the physical description of second law and its application to heat engine, refrigerator and heat pump.
3. Also understand the concepts of entropy and able to find out the entropy generated in a thermodynamic systems
4. Understand the properties of pure substance and ideal gas concepts
5. Describe the importance of availability concept and able to apply the thermodynamic relations in applications.
6. Understand the psychometric properties and various processes to create human comfort at various physical conditions

UNIT I BASIC CONCEPTS AND FIRST LAW 9+3

Basic concepts - Classical and Statistical approaches - Thermodynamic systems - closed, open, isolated. Property – State - Process-adiabatic - Quasi-static process – Cycle - Point and Path function – Energy - Work transfer - Concept of temperature and heat- Zeroth law of thermodynamics - Concept of ideal gases - First law of thermodynamics –PMM1, internal energy, specific heat capacities, enthalpy, and its application to closed system and open system-steady flow energy equation.

UNIT II SECOND LAW AND ENTROPY 9+3

Physical description of the second law - Kelvin-Planck and Clausius statements –Equivalence - Reversible processes and cycles- Carnot cycle – Corollaries - Absolute temperature scale – Clausius Theorem, inequality - Entropy- Principle, transfer, generation, balance - Third law of thermodynamics

UNIT III THERMODYNAMIC AVAILABILITY AND RELATIONS

Basics-Dead state, quality of energy, degradation of energy - Reversible processes – Maximum work - Exergy – Closed system - Steady flow system – Irreversibility - Exergy Balance - Second law efficiency – Exact differentials - Tds Relations - Maxwell's Relation – Clausius – Clapeyron Equation - Joule-Thompson Coefficient.

UNIT IV PROPERTIES OF PURE SUBSTANCE AND GAS MIXTURES

Pure substance - Phase change process - Property diagrams - PVT surface - Steam – types, dryness fraction - Avogadro's law - Ideal Gas - Equations of state-Vander Waal's equation - Real Gas - Compressibility and its chart - Mixtures of Gases – Properties.

UNIT V PSYCHROMETRY 9+3

Psychrometry - Psychrometric charts - Property calculations of air vapour mixtures- Psychrometric process-Adiabatic mixing - Evaporative cooling

TOTAL 45 + 15 = 60 PERIODS

(Permitted to use standard thermodynamic table, Mollier diagram, and Psychometric chart in the examination)

SUGGESTED READINGS

1. Nag P K, Engineering Thermodynamics, 5e, Tata McGraw-Hill, New Delhi, 2013
2. Cengel, Thermodynamics-An Engineering Approach, 8e, Tata McGraw-Hill, New Delhi, 2015
3. Holman J P, Thermodynamics, McGraw-Hill, NewDelhi, 1988
4. C P Arora, Thermodynamics, McGraw-Hill, NewDelhi, 2001
5. Kothandaraman C P and Domkundwar S, A Course in Thermal Engineering, Dhanpatrai& Sons, New Delhi, 2004

19PBEME302 ENGINEERING MATERIALS AND METALLURGY SEMESTER – III 3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To impart knowledge on metallurgical aspects of metals.
2. To understand heat treatment processes on different grades of steel.
3. To familiarize on selection of ferrous and non-ferrous materials for various applications.
4. To impart knowledge on non-metallic materials
5. To learn about the strengthening mechanisms for Non-ferrous alloys.
6. To comprehend the significance of Non-Destructive Testing (NDT)methods.

COURSE OUTCOMES

Learners should be able to:

1. Identify the metallurgical aspects of metals.
2. Identify suitable heat treatment processes for various applications.
3. Select appropriate ferrous and non-ferrous materials for various applications.
4. Identify and select suitable non-metallic materials.
5. Identify suitable strengthening mechanisms for Non-ferrous alloys.
6. Work with non-destructive testing methods.

UNIT I CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS 9

Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, peritectic, eutectoid and peritectoid reactions, Iron – Iron carbide equilibrium diagram -Classification of steel and cast Iron, microstructure, properties and applications.

UNIT II HEAT TREATMENT 9

Definition – Full annealing, stress relief, recrystallisation and spheroidizing –normalising, hardening and tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on TTT diagram, CCT - Hardenability, Jominy end quench test – Austempering, martempering – case hardening - carburising, nitriding, cyaniding, carbonitriding – Flame and Induction hardening, Microstructure study and specimen preparation.

UNIT III FERROUS AND NON FERROUS METALS 9

Effect of alloying elements on steel (Mn, Si, Cr, Mo, V, Ti & W) - stainless and tool steels – HSLA - maraging steels – Gray, White malleable, Spheroidal Graphite irons - Copper and Copper alloys – Brass, Bronze and Cupronickel – Aluminum and Al-Cu – precipitation, strengthening treatment – Bearing alloys.

UNIT IV NON-METALLIC MATERIALS 9

Polymers – types of polymer, commodity and engineering polymers – Properties and Applications of thermoplastics (PP, PVC, ABS, and PMMA) and thermosetting plastics (PF, UF, MF) –Engineering Ceramics.

UNIT V TESTING OF MECHANICAL PROPERTIES AND INSPECTION 9

Mechanism of plastic deformation, slip and twinning – Types of fracture – Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell), Impact test - Izod and Charpy, Fatigue and creep test, S-N curve.

Non Destructive Testing: Non Destructive Testing basic principles and testing method of Radiographic testing, Ultrasonic testing, Magnetic particle test and Liquid penetrant test, Eddy current testing.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Kenneth G.Budinski and Michael K.Budinski, Engineering Materials: Properties and Selection, Prentice-Hall of India Private Limited, New Delhi, 2010
2. William D. Callister & David G. Rethwisch, Fundamentals of Materials Science and Engineering: An Integrated Approach, 5e, International Student Version, John Wiley & Sons, Inc., 2016
3. Raghavan. V, Materials Science and Engineering, 6e, Prentice Hall of India Pvt. Ltd, New Delhi, 2015
4. James F. Shackelford
5. Madanapalli K. Muralidhara, Introduction to Materials Science for Engineers, 6e, Pearson Education, India, 2014

19PBEME303 INDUSTRIAL METROLOGY SEMESTER – III
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To provide knowledge on various Metrological equipments available to measure the dimension of the components
2. To learn the importance of precision measurements.
3. To understand the concepts of linear and angular measurements.
4. To study different profile measurements used in practice.
5. To acquire knowledge on laser measurements and CMM.
6. To gain knowledge on measurement of mechanical and thermal quantities.

COURSE OUTCOMES

Upon completion of this course, the Students can

1. Understand the basics of measurements and quality standards
2. Apply the concept of measurements in practical applications.
3. Measure linear and angular measurements.
4. Carry out profile measurements in engineering components.
5. Exhibit measurements in practice using laser and CMM.
6. Perform measurements on mechanical and thermal quantities

UNIT I BASICS OF MEASUREMENT, DEVICES AND QUALITY STANDARDS 9

Definition of metrology, economics of measurement, measurement as a comparative process, dimensional properties, terminology and accuracy of measurement, measuring errors, Abbe's Principle, Principle of interferometry- flatness testing, optical interferometer, laser interferometer. Holography and speckle metrology.

General cares and rules in measurement, International standardization, SI units and quantities, BIS- NPL – advantages, ISO 9000 quality standards, QS 9000 standards, Environment standards, metrology room measuring standards room.

UNIT II LINEAR MEASUREMENTS 9

Material length standards –line and end measurement – calibration of end bars, datum and reference surfaces, surface plates, gauges – feeler gauges, micrometers, dial test indicator, slip gauges, care of gauge blocks, Comparators- mechanical, electrical, optical and pneumatic, optical projector.

UNIT III GEOMETRICAL MEASUREMENT 9

Angular measurement – plain vernier and optical protractors, sine bar, optical instruments, flatness, parallelism and roundness measurement, need for limit gauge, design of plug gauge, Taylor's principle, three basic types of limit gauges, surface texture, reasons for controlling surface texture, parameters used , specification of surface texture, drawing and symbols, Tomilson surface meter. CMM.

UNIT IV METROLOGY OF MACHINE ELEMENTS 9

Types of screw threads, terminology, proportions of ISO metric thread, measurement of major, minor and effective diameters. Gear terminology and standard proportions, spur gear measurement, checking of composite errors, base pitch measurement, clean room environment.

UNIT V MACHINE INSTALLATION AND TESTING 9

Equipment erection, commissioning, testing procedure for lathe, milling, continuous process line. First aid, safety precautions in installation of equipment, protocol for repair and testing, inspection check list.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Gupta I C, A text book of Engineering Metrology, Dhanpat Rai publications, New Delhi, 2006
2. Jain R K, Mechanical and Industrial Measurements, Khanna Publishers Co Ltd., New Delhi, 2014
3. Jack Holman, Experimental Methods for Engineers, Tata McGraw Hill Publications Co Ltd, 2012
4. Narayana K, Engineering Metrology, Scitech Publication, 2006
5. Kaniska Bedi, Quality Management, Oxford University Press, Chennai, 2007

19PBEME304 FLUID MECHANICS & FLUID MACHINES SEMESTER – III
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To enrich the understanding of fluid properties
2. To make the students conversant with types of flow and calculate Major and minor loses in pipes.
3. To acquaint the student with the concepts of Buckingham's π theorem.
4. To explain the working of different pumps
5. To explain the working of different turbines.
6. To equip students with skills to produce analytical solutions to various simple problems

COURSE OUTCOMES

Upon completion of this course, the students can able to

1. Demonstrate basic knowledge of fluid properties
2. Find types of flow and calculate Major and minor loses in pipes.
3. Apply Buckingham's π theorem for problem solving.
4. Understand the working of different pumps
5. Understand the working of different turbines.
6. produce analytical solutions to various simple problems

UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS 9

Fluid properties: Mass density, weight density, specific gravity, viscosity, compressibility, surface tension and capillarity. Buoyancy and floatation– metacentre and metacentric height (definition only)

Flow characteristics: concepts of system and control volume, application of control volume to continuity equation, energy equation, momentum equation and moment of momentum equation.

UNIT II FLOW THROUGH CIRCULAR PIPES 9

Hydraulic and energy gradient – Types of fluid flow – Laminar flow through circular conduits – 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 9

Dimension and units, dimensional homogeneity, applications of Buckingham's π theorem, model and similitude, similarity laws.

UNIT IV HYDRAULIC TURBINES 9

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.

UNIT V HYDRAULIC PUMPS 9

Classification of pumps – centrifugal pump–working principle–head, discharge, efficiencies and losses – performance curves – specific speed. Reciprocating pump–components and working–slip–indicator diagram – air vessel – Jet pump – Gear pump – Submersible pump.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Victor L Streeter, E. Benjamin Wylie and K.W. Bedford, Fluid Mechanics, 9e, McGraw–Hill, New Delhi, 2010
2. Kumar K.L, Engineering Fluid Mechanics, S. Chand, 2015
3. Bansal. R.K, Fluid Mechanics and Hydraulics Machines, Laxmi publications (P) Ltd, New Delhi, 2016
4. White. F.M, Fluid Mechanics, 8e, Tata McGraw–Hill, New Delhi, 2016
5. Fox and McDonald, Fluid Mechanics, 8e, John Wiley, 2015

19PBEME311 FLUID MECHANICS AND METROLOGY LABORATORY SEMESTER – III 3H: 2C

Instruction Hours / Week: - L: 0 T: 0 P: 3 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To supplement the theoretical knowledge gained in Fluid Mechanics and Machinery with practical testing
2. To understand the concepts of coefficient of discharge for Orifice meter and Venturi meter, Rotameter.
3. To understand the importance of friction factor for flow through pipes, performance of various pumps and turbines
4. To introduce the concepts to Characterize and calibrate measuring devices.
5. To expose students to measuring taper angle straightness, flatness, surface finfish and thread parameters.
6. To explain the limits of dimensional tolerances using comparators.

COURSE OUTCOMES

1. Calculate the coefficient of discharge for Orifice meter and Venturimeter, Rotameter
2. Estimate the friction factor for flow through pipes, performance of various pump
3. Determine of jump speed and profile of the cam, moment of inertia by oscillation method for connecting rod and flywheel.
4. Asses the performance of turbine. Characterize and calibrate measuring devices.
5. Measure taper angle straightness, flatness, surface finfish and thread parameters.
6. Examine the limits of dimensional tolerances using comparators.

LIST OF EXPERIMENTS

- **FLUID MECHANICS**

1. Determination of the Coefficient of discharge of given Orifice meter.
2. Determination of the Coefficient of discharge of given Venturimeter.
3. Calculation of the rate of flow using Rota meter.
4. Determination of friction factor for a given set of pipes.
5. Conducting experiments and drawing the characteristic curves of centrifugal pump
6. Conducting experiments and drawing the characteristic curves of submergible pump
7. Conducting experiments and drawing the characteristic curves of reciprocating pump.
8. Conducting experiments and drawing the characteristic curves of Gear pump.
9. Conducting experiments and drawing the characteristic curves of Pelton wheel.
10. Conducting experiments and drawing the characteristics curves of Francis turbine.

- **METROLOGY**

1. Calibration of Vernier / Micrometer / Dial gauge
2. Checking dimensions of part using slip gauges
3. Measurement of gear tooth dimensions – addendum, dedendum, pitch circle diameter and tooth thickness
4. Measurement of taper angle using sine bar / tool makers microscope
5. Measurement of straightness and flatness
6. Measurement of thread parameters
7. Checking the limits of dimensional tolerances using comparators (Mechanical / Pneumatic / Electrical)
8. Surface finish measurement

19PBEME401 APPLIED THERMODYNAMICS SEMESTER – IV
4H: 4C

Instruction Hours / Week: - L: 3 T: 1 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To incorporate the concepts and laws in thermodynamic analysis of cyclic processes.
2. To impart the mechanisms of combustion of fuels.
3. To apply the thermodynamic concepts in steam turbines and nozzles.
4. To learn about the performance of compressors.
5. To understand the concept of cogeneration and waste heat recovery in engineering applications.
6. To introduce concepts of refrigeration and air conditioning in engineering applications

COURSE OUTCOMES

Learners should be able to

1. Calculate the efficiency of various gas power cycles.
2. Calculate the performance characteristics of engines.
3. Analyze combustion mechanism in I engines.
4. Evaluate the characteristic of steam turbines and nozzles.
5. Evaluate the performance characteristics of compressors.
6. Identify and utilize the concepts of refrigeration and air conditioning in engineering applications

UNIT I GAS POWER CYCLES AND IC ENGINES 9+3

Otto, Diesel, Dual, Brayton cycles – Calculation of mean effective pressure and air standard efficiency – actual and theoretical PV and TS diagrams of two stroke and four stroke engines–valve timing diagram and port timing diagram – calculation of engine performance, heat balance sheet, retardation – Morse test.

UNIT II BOILER AND STEAM POWER CYCLES 9+3

Generation of steam, Boiler–Classification, fire tube boiler, water tube boiler, comparison, boiler mountings and accessories, performance of steam boilers – dryness fraction, properties of steam, T–S diagram, Mollier diagram, steam tables, Rankine Cycle – incomplete evaporation – superheated steam –modified cycle.

UNIT III STEAM NOZZLES AND STEAM TURBINES 9+3

Steam nozzles – flow through steam nozzles, effect of friction, critical pressure ratio, super saturated flow – Steam turbines– impulse and reaction turbine, compounding, velocity diagram, condition for maximum efficiency – multi stage turbines, cycles with reheating and regenerating heating – reheat factor, degree of reaction - governing of turbines.

UNIT IV AIR COMPRESSORS 9+3

Classifications of compressors – Reciprocating air compressor – performance characteristics, effect of clearance volume, free air delivery and displacement, intercooler, after cooler – Rotary compressor – vane type, centrifugal and axial, flow performance characteristics.

UNIT V REFRIGERATION AND AIR CONDITIONING 9+3

Fundamentals of refrigeration – COP – Vapour compression refrigeration system – cycle, p–h chart, Vapour absorption system – comparison, properties of refrigerants. Fundamentals of air conditioning system, cycle, controls, air handling and distribution, simple cooling and heat load estimation

(Permitted to use standard thermodynamic table, Mollier diagram, Psychometric chart and Refrigeration property table in the examination)

TOTAL 45+15 = 60 PERIODS

SUGGESTED READINGS

1. Rajput R.K, Thermal Engineering, Sixth edition, Laxmi Publications, New Delhi, 2015
2. Arora C.P, Refrigeration and Air conditioning, Tata McGraw–Hill, New Delhi, 2008
3. Kothandaraman C.P, and Domkundwar A.V, A course in Thermal Engineering, Fifth Edition, Dhanpat Rai and Sons, Delhi, 2006
4. Ganesan V, Internal Combustion Engines, 4e, Tata McGraw–Hill, New Delhi, 2012
5. Yunus A Cengel, Thermodynamics' An Engineering Approach, 8e, Tata McGraw Hill, New Delhi, 2015

19PBEME402 DESIGN OF MECHATRONIC SYSTEMS SEMESTER – IV
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To introduce the concepts of sensors and transducers.
2. To familiarize the students to understand the actuation systems.
3. To understand the importance of architecture of microprocessors.
4. To Study and acquire knowledge of the PLC program using ladder logic.
5. To introduce the concepts of design mechatronic system.
6. To provide an overview of develop the controller model for electrical, mechanical and thermal systems

COURSE OUTCOMES

1. Implement the concepts of sensors and transducers.
2. Design the actuation systems.
3. Understand the architecture of microprocessors.
4. Create the PLC program using ladder logic.
5. Design mechatronic system.

UNIT I MECHATRONICS SENSORS AND TRANSDUCERS 9

Introduction to Mechatronics – Systems – Measurement Systems – Control Systems –Traditional design – Microprocessor based Controllers. Introduction to sensors – Performance Terminology – Static and Dynamic characteristics – Displacement – Position and Proximity – Velocity and Motion – Fluid Pressure – Temperature Sensors – Light Sensors – Selection of Sensors – Signal processing – Servo systems.

UNIT II ACTUATORS AND SYSTEM MODELS 9

Pneumatic and Hydraulic Systems – Directional Control Valves – Rotary Actuators. Mechanical Actuation Systems – Cams – Gear Trains – Ratchet and pawl – Belt and Chain Drives – Bearings. Electrical Actuation Systems – Mechanical Switches – Solid State Switches – Solenoids – D.C Motors – A.C Motors – Stepper Motors.
Introduction to system models– Building block of Mechanical, Electrical, Fluid and Thermal Systems.

UNIT III MICROPROCESSORS IN MECHATRONICS 9

Introduction – Architecture – pin configuration Instruction set – Programming of Microprocessors using 8085 instructions – Interfacing. Input and output devices – interfacing D/A converters and A/D converters – Application – Temperature control – Stepper motor control.

UNIT IV CONTROLLERS 9

Introduction –Continuous and discrete process Controllers – Control Mode – Two – Step mode – Proportional Mode – Derivative Mode – Integral Mode – PID Controllers –Digital Controllers – Adaptive Control – Digital Logic Control – Micro Processors Control. Introduction to PLC – Basic Structure – Input / Output Processing – Programming – Mnemonics – Timers, Internal relays and counters – Data Handling – Analog Input / Output – Selection of a PLC.

UNIT DESIGN OF MECHATRONIC SYSTEMS 9

Stages in designing Mechatronics Systems – Traditional and Mechatronic Design – Possible Design Solutions – Case Studies of Mechatronics Systems, Pick and place robot – automatic Car Park Systems – Engine Management Systems – Introduction to MEMS.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Bolton W, Mechatronics (Anna University): A Multidisciplinary, 4/e, Pearson Education, Delhi, 2015
2. Michael B. Histand David G. Alciatore, Introduction to Mechatronics and Measurement Systems, 4e, McGraw–Hill International Editions, New York, 2011
3. Nitaigour Premchand Mahalik, Mechatronics : Principles, Concepts and Applications, 1e, McGraw–HillEducation, New Delhi, 2003
4. Ghosh P.K and Sridhar P.R, Introduction to Microprocessors for Engineers and Scientist, Prentice Hall of India, New Delhi, 2009

19PBEME403 DESIGN OF MACHINE ELEMENTS SEMESTER – IV
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To understand the various types of stresses induced in different machine members.
2. To Study and acquire knowledge on design shaft and couplings for effective transmission of power.
3. To study the features of welded joints and fasteners required for various industrial applications.
4. To give exposure to design springs and flywheels for various engineering applications.
5. To understand the importance design bearings and levers for engineering applications.
6. To make the students conversant to implement design procedure for designing a machine.

COURSE OUTCOMES

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

1. Determine various types of stresses induced in different machine members.
2. Design shaft and couplings for effective transmission of power.
3. Select thetype of welded joints and fasteners required for various industrial applications.
4. Design springs and flywheels for various engineering applications.
5. Design bearings and levers for engineering applications.
6. Implement design procedure for designing a machine.

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UNIT I STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS 9

Introduction to the design process – factors influencing machine design, selection of materials based on mechanical properties – Factor of safety. Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading – Design of curved beams – crane hook and 'C' frame – theories of failure – stress concentration – design for variable loading – Soderberg, Goodman and Gerber relations.

UNIT II DESIGN OF SHAFTS AND COUPLINGS 9

Design of solid and hollow shafts based on strength, rigidity and critical speed – Design of keys and key ways – Design of rigid and flexible couplings – Introduction to gear and shock absorbing couplings – design of knuckle joints.

UNIT III DESIGN OF FASTENERS AND WELDED JOINTS 9

Threaded fasteners – Design of bolted joints including eccentric loading – Design of welded joints for pressure vessels and structures – theory of bonded joints.

UNIT IV DESIGN OF SPRINGS AND FLYWHEEL 9

Design of helical, leaf, disc and torsional springs under constant loads and varying loads – Concentric torsion springs – Belleville springs – Design of flywheels involving stresses in rim and arm.

UNIT V DESIGN OF BEARINGS AND LEVERS 9

Selection of bearings – sliding contact and rolling contact types – Cubic mean load – Selection of journal bearings – McKees equation – Lubrication in journal bearings – calculation of bearing dimensions – Design of Levers.

TOTAL 45 PERIODS

(Permitted to use PSG design data book in the examination)

SUGGESTED READINGS

1. Juvinall R.C and Marshek K.M, Fundamentals of Machine Component Design, 5e, John Wiley and Sons, New Delhi, 2015
2. Bhandari V.B, Design of Machine Elements, 4e, Tata McGraw–Hill Book Co, New Delhi, 2016
3. Norton R.L, Design of Machinery, Tata McGraw–Hill Book Co., New Delhi, 2011
4. Orthwein W, Machine Component Design, Jaico Publishing Co., New Delhi, 2013
5. Bhandari V B, Introduction To Machine Design, McGraw–Hill Book Co., New York, 2013
6. Spotts M.F, Shoup T.E, Design of Machine Elements, Pearson Education, New Delhi, 2008

19PBEME404 ENVIRONMENTAL SCIENCE SEMESTER – IV
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To create the awareness about environmental problems among people.
2. To develop an attitude of concern for the environment.
3. To motivate public to participate in environment protection and improvement.
4. To demonstrate proficiency in quantitative methods, qualitative analysis, and critical thinking.
5. To develop writing and oral communication needed to conduct high-level work as interdisciplinary scholars and / or practitioners.
6. To Learn about the systems concepts and methodologies to analyze and understand interactions.

COURSE OUTCOMES

1. Master core concepts and methods from ecological and physical sciences and their application in environmental problem solving.
2. Master core concepts and methods from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.
3. Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.
4. Understand the transnational character of environmental problems and ways of addressing them, including interactions across local to global scales.
5. Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes.
6. Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.

UNIT I INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURALRESOURCES 9

Definition, Scope and Importance – Need for public awareness -Forest resources: Use and over-exploitation, deforestation-Water resources-Use and over-utilization of surface and ground water, floods, drought, conflicts over water- Land resources-Land as a resource, land degradation, man induced landslides, soil erosion and desertification –Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources- Food resources-World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture- Energy resources-Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources- role of an individual in conservation of natural resources.

UNIT II ECOSYSTEM 9

Chemistry and Environment- Environmental segments, Composition and Structure of atmosphere- Concept of an ecosystem- Structure, components and function of an ecosystem Energy flow in the ecosystem – Food chain, food web and ecological pyramids, Structure and function of Terrestrial ecosystem (Forest, Desert and Grassland ecosystem) and Aquatic ecosystem (Fresh water and Marine ecosystem)

UNIT III BIODIVERSITY 9

Introduction to biodiversity, Definition- Genetic diversity, Species diversity and Ecosystem diversity, Biogeographical classification of India, Importance of biodiversity-Value of biodiversity - 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 IV ENVIRONMENTAL POLLUTION 9

Definition – Causes, effects and control Measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution and Thermal pollution. Solid waste management-.Causes, effects and control measures of urban and industrial wastes– Role of an individual in prevention of pollution–Disaster management:-earthquake, tsunami, cyclone and landslides.

UNIT V SOCIAL ISSUES AND ENVIRONMENT 9

From unsustainable to Sustainable development,Urban problems related to energy sources, water conservation, Rain water harvesting and watershed management, Resettlement and rehabilitation of people, its problems and concerns, Environmental ethics- Issues and possible solutions- Climate change- Green house effect and global warming, acid rain, ozone layer depletion, Wasteland reclamation- Environment Protection Act- Human Rights-Value Education, Role of

Information Technology in Environment and human health-Population growth, variation of population among nations-Population explosion.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Ravikrishnan, A, Environmental Science, Sri Krishna Hi tech Publishing Company Private Ltd., Chennai, 2012
2. Anubha kaushik, C.P. Kaushik, Environmental Science and Engineering, New Age International (p) Ltd., New Delhi., 2010
3. Benny Joseph, Environmental Science and Engineering, Tata Mc Graw -Hill Publishing Company, New Delhi, 2005
4. William P.Cunningham, Principles of Environmental Science, Tata Mc Graw -Hill Publishing Company, New Delhi., 2008
5. Linda D. Williams, Environmental Science Demystified, Tata Mc Graw -Hill Publishing Company Limited, New Delhi., 2005
6. Bharucha Erach, Environmental Science Demystified, Mapin Publishing (P) Ltd., Ahmedabad., 2005
7. Tyler Miller G. Jr, Environmental Science, Thomson & Thomson Publishers, New Delhi., 2004
8. Trivedi, R.K. and Goel, P.K, Introduction to Air Pollution, Techno-Science Publications, Jaipur., 2003

19PBEME411 THERMAL ENGINEERING LABORATORY SEMESTER – IV
3H: 2C

Instruction Hours / Week: - L: 0 T: 0 P: 3 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To provide an overview of performance of four stroke single cylinder CI engine.
2. To provide an overview of performance of steam generator and steam turbines.
3. To impart knowledge on thermal conductivity of various engineering materials.
4. To acquaint the student with the concepts of heat transfer rate in free and forced convection environment.
5. To Study and acquire knowledge of grey surface.
6. To study the features of Stefan–Boltzmann constant.

COURSE OUTCOMES

1. Sketch the valve timing diagram for four stroke diesel engine and petrol engines.
2. Evaluate the performance of four stroke single cylinder CI engine.
3. Measure the flash and fire point of various fuel/lubricants.
4. Measure heat transfer rate in free and forced convection environment
5. Determine the grey surface and Stefan–Boltzmann constant
6. Measure the effectiveness of parallel and counter flow heat exchanger.

LIST OF EXPERIMENTS

I C ENGINES AND FUELS

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

HEAT TRANSFER

1. Heat transfer through a composite wall
2. Thermal conductivity measurement by guarded plate method
3. Natural convection heat transfer from a vertical cylinder
4. Heat transfer from pin–fin (natural and forced convection modes)
5. Effectiveness of Parallel/counter flow heat exchanger
6. Determination of Stefan–Boltzmann constant
7. Determination of emissivity of a grey surface

TOTAL 45 PERIODS

19PBEME501 HEAT AND MASS TRANSFER SEMESTER – V
4H: 4C

Instruction Hours / Week: - L: 3 T: 1 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To Study and acquire knowledge on heat transfer for conduction.
2. To introduce the concepts of heat transfer coefficients for natural and forced convection for different fluid flows.
3. To understand the performance of heat exchanger.
4. To study the features of radiation heat transfer between the surfaces.
5. To give exposure to mass transfer.
6. To make the students conversant to solve complex problems where heat and mass transfer takes place.

COURSE OUTCOMES

1. Determine the rate of heat transfer for conduction.
2. Evaluate heat transfer coefficients for natural and forced convection for different fluid flows.
3. Analyze performance of heat exchanger.
4. Estimate the radiation heat transfer between the surfaces.
5. Calculate the coefficient of mass transfer.
6. Solve complex problems where heat and mass transfer takes place

UNIT I CONDUCTION 9 + 3

Basic Concepts – Mechanism of Heat Transfer – Conduction, Convection and Radiation – General Differential equation of Heat Conduction – Fourier Law of Conduction – Cartesian and Cylindrical Coordinates – One Dimensional Steady State Heat Conduction – Conduction through Plane Wall, Cylinders and Spherical systems – Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Use of Heislers Chart.

UNIT II CONVECTION 9 + 3

Basic Concepts – Convective Heat Transfer Coefficients – Boundary Layer Concept – Types of Convection – Forced Convection – Dimensional Analysis – External Flow – Flow over Plates, Cylinders and Spheres – Internal Flow – Laminar and Turbulent Flow – Combined Laminar and Turbulent – Flow over Bank of tubes – Free Convection – Dimensional Analysis – Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and Spheres.

UNIT III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS 9 + 3

Nusselts theory of condensation–pool boiling, flow boiling, correlations in boiling and condensation. Types of Heat Exchangers – LMTD Method of heat Exchanger Analysis – Effectiveness – NTU method of Heat Exchanger Analysis – Overall Heat Transfer Coefficient – Fouling Factors.

UNIT IV RADIATION 9 + 3

Basic Concepts, Laws of Radiation – Stefan Boltzman Law, Kirchoff Law –Black Body Radiation –Grey body radiation - Shape Factor Algebra – Electrical Analogy – Radiation Shields –Introduction to Gas Radiation.

UNIT V MASS TRANSFER 9 + 3

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 45 + 15 = 60 PERIODS

(Permitted to use standard Heat and Mass Transfer Table in the examination)

SUGGESTED READINGS

1. Sachdeva R.C, Fundamentals of Engineering Heat and Mass Transfer, 4e, New Age International, New Delhi, 2012
2. Frank P. Incropera and David P. DeWitt, Fundamentals of Heat and Mass Transfer, 7e, John Wiley and Sons, New Delhi, 2011
3. Jack P. Holman, Heat Transfer, 10e, McGraw–Hill Book Co, New Delhi, 2017
4. Kothandaraman C.P, Fundamentals of Heat and Mass Transfer, New Age International, New Delhi, 2012

19PBEME502 OPERATIONS RESEARCH SEMESTER – V
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To Formulate and solve engineering and managerial situations as LPP.
2. To understand theEngineering and Managerial situations in Transportation.
3. To Study and acquire knowledge on engineering and Managerial solutions in Assignment and scheduling problems.
4. To give exposure to inventory in industry.
5. To make the student acquire sound knowledge on sequences to perform operation among various alternatives.
6. To provide an overview of various tools in various sections of industries like marketing, material handling etc.

COURSE OUTCOMES

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

1. Formulate and solve engineering and managerial situations as LPP.
2. Solve Engineering and Managerial situations in Transportation.
3. Give Engineering and Managerial solutions in Assignment and scheduling problems.
4. Manage inventory in industry.
5. Select better sequence to perform operation among various alternatives.
6. Apply the various tools in various sections of industries like marketing, material handling etc.

UNIT I INTRODUCTION TO OPERATIONS RESEARCH 9

Operations research and decision–making – types of mathematical models and constructing the model – Role of computers in operations research –Linear Programming Techniques: Formulation of linear programming problem, applications and limitations, graphical method, simplex method – The Big –M method – the two–phase method.

UNIT II TRANSPORTATION PROBLEMS 9

Least cost method, North west corner rule, Vogel's approximation method, modified distribution method, optimization models, unbalance and degeneracy in transportation model.

UNIT III ASSIGNMENT MODELS AND SCHEDULING 9

Assignment models - Hungarian algorithm, unbalanced assignment problems - maximization case in assignment problems, traveling salesman problem. Scheduling – processing n jobs through two machines, processing n jobs through three machines, processing two jobs through 'm' machines, processing n jobs through m machines.

UNIT IV INVENTORY CONTROL AND QUEUING THEORY 9

Variables in inventory problems, inventory models with penalty, shortage and quantity discount, safety stock, multi item deterministic model.

Queuing Models: Queues – Notation of queues, performance measures, The M/M/1 queue, The M/M/m queue, batch arrival queuing system, queues with breakdowns.

UNIT V PROJECT MANAGEMENT, GAME THEORY, REPLACEMENT MODELS 9

Basic terminologies, constructing a project network, network computations in CPM and PERT, cost crashing –Replacement Models: Replacement of Items due to deterioration with and without time value of Money, Group replacement policy, Staff replacement

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Kanti Swarup, Gupta P.K and Manmohan, Operations Research, Sultan Chand and Sons, New Delhi, 2010
2. Viswanathan N and Narahari Y, Performance Modeling of Automated Manufacturing Systems, Prentice Hall Inc, Newyork, 2000
3. Prem kumar Gupta and Hira D.S, Operation Research, S Chand and Company Limited, New Delhi, 2015

19PBEME503 DESIGN OF TRANSMISSION SYSTEMS SEMESTER - V
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To Study and acquire knowledge on design the power transmission components like belts, pulleys, ropes, chains and sprockets.
2. To Study and acquire knowledge on design spurs and parallel axis helical gears.
3. To give exposure to dimensions for bevel and worm gears.
4. To provide an overview of design procedures of gear boxes for industrial applications.
5. To provide an overview of clutches and brakes for engineering applications.
6. To make the student acquire sound knowledge of mechanical system

COURSE OUTCOMES

Upon completion of this course, the students will able to

1. Design the power transmission components like belts, pulleys, ropes, chains and sprockets.
2. Design spurs and parallel axis helical gears.
3. Estimate the dimensions for bevel and worm gears.
4. Practice the design procedures of gear boxes for industrial applications.
5. Design clutches and brakes for engineering applications.
6. Design a mechanical system.

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UNIT I DESIGN OF TRANSMISSION SYSTEMS FOR FLEXIBLE ELEMENTS 9

Design of V belts and pulleys – Selection of Flat belts and pulleys – Wire ropes and pulleys – Selection of Transmission chains and Sprockets – Design of sprockets.

UNIT II DESIGN OF SPUR AND HELICAL GEARS 9

Gear Terminology – Speed ratios and number of teeth–Force analysis – Tooth stresses – Dynamic effects – Fatigue strength – Factor of safety – Gear materials – Module and Face width–power rating calculations based on strength and wear considerations – Parallel axis Helical Gears & cross helical gears - Terminology– Pressure angle in the normal and transverse plane– Equivalent number of teeth–forces and stresses – Estimating the size of the helical & cross helical gears.

UNIT III DESIGN OF BEVEL AND 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 DESIGN OF GEAR BOXES 9

Geometric progression – Standard step ratio – Ray diagram, kinematics layout –Design of sliding mesh gear box –Constant mesh gear box. – Design of multi speed gear box.

UNIT V DESIGN OF CLUTCHES AND BRAKES 9

Design of plate clutches –axial clutches–cone clutches–internal expanding rim clutches–internal and external shoe brakes.

TOTAL 45 PERIODS

(Permitted to use PSG design data book in the examination)

SUGGESTED READINGS

1. Robert C. Juvinall, Kurt M. Marshek, Fundamentals of Machine Component Design, John Wiley and Sons., London, 2017
2. Bhandari V B, Design of Machine Elements, Tata McGraw Hill, 2016
3. Maitra G.M., Prasad L.V, Hand book of Mechanical Design, Tata McGraw–Hill, New Delhi, 2009
4. Shigley J.E, Mischke C.R, Shigley's Mechanical Engineering Design
5. 10e, McGraw–Hill International Editions, New Delhi, 2015
6. Gope P C, Machine Design : Fundamentals And Applications, PHI learning, India, 2012

19PBEME5E-	**PROFESSIONAL ELECTIVE - I**	**SEMESTER – V**
-		**3H: 3C**

19PBEME511	**COMPUTER AIDED MANUFACTURING LABORATORY**	**SEMESTER – V**
		3H: 2C

Instruction Hours / Week: - L: 0 T: 0 P: 3 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To study the features of CNC Machine Tool.
2. To expose students to modern control systems (Fanuc, Siemens etc.,)
3. To know the application of various CNC machines like CNC lathe, CNC Vertical Machining centre
4. To facilitate the understanding of manufacturing drawings from the models created
5. To understand the importance of CAM, CREO, etc
6. To acquaint the student with the concepts of mat lab for performing various mathematical operations

COURSE OUTCOMES

Upon completion of this course, the students can able to

1. use computer and CAD software's for modeling of mechanical components
2. use various options in Solid Works for modeling of given components
3. create assembly of components
4. Understand geometric transformation techniques in CAD.
5. Develop mathematical models to represent curves and surfaces and model engineering components using solid modeling techniques.
6. Develop CNC programs to manufacture industrial components.

COMPUTER AIDED MANUFACTURING (CAM)

1. MANUAL PART PROGRAMMING (Using G and M Codes) in CNC Machine.
2. Part programming for Linear, Circular interpolation, and Contour motions.
3. Part programming using standard canned cycles for Thread cutting, Drilling, Peck drilling, and Boring.
4. NC code generation using software's like Edge CAM, CREO, etc. CNC Controllers like FANUC, Siemens, and Hiedenhain etc.

TOTAL 45 PERIODS

19PBEME601 ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT SEMESTER – VI 3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To enable students to understand the fundamental economic concepts applicable to engineering
2. To learn the techniques of incorporating inflation factor in economic decision making.
3. To Understand the measures of national income, the functions of banks and concepts of globalization
4. To Apply the concepts of financial management for project appraisal
5. To Understand accounting systems and analyze financial statements using ratio analysis
6. To Understand Financial planning, economic basis for replacement.

COURSE OUTCOMES

1. Evaluate the economic theories, cost concepts and pricing policies.
2. Understand the market structures and integration concepts
3. Understand the measures of national income, the functions of banks and concepts of globalization
4. Apply the concepts of financial management for project appraisal
5. Understand accounting systems and analyze financial statements using ratio analysis
6. Understand the impact of inflation, taxation, depreciation. Financial planning, economic basis for replacement, project scheduling, and legal and regulatory issues are introduced and applied to economic investment and project-management problems

UNIT 1 FUNDAMENTALS OF ENGINEERING ECONOMICS 9

Introduction to Engineering Economics – Definition, Scope and Significance – Demand and supply analysis – Definition – Law of Demand – Elasticity of Demand – Demand Forecasting – Supply – Law of supply – Elasticity of Supply.

UNIT II COMMERCIAL BANKING 9

Law of contracts, negotiable instruments, its types and regulations there on – New Industrial Policy – MSME sector – Development financial institutions and their relevance – Export Promotion - DICGC, ECGCI, EXIM Bank - Import and export concepts - Letter of credit, forward contracts / hedging.

UNIT III CAPITAL MARKET 9

Stock Exchanges – Functions – Listing of Companies – Role of SEBI – Capital Market Reforms. Money and banking - Money – Functions –Inflation and deflation – Commercial Bank and its functions – Central bank and its functions.

UNIT IV FINANCIAL CONCEPTS 9

Introduction, scope and objectives of basic financial concepts – time value of money – Interest - simple & compound interest, annuity and effective rate of interests. Appraisal of project for profitability, internal rate of return – payback period – net present value. NPV comparison – cost benefit analysis. Sources of finance – internal and external.

UNIT V COST ANALYSIS AND BREAK EVEN ANALYSIS 9

Cost analysis - Basic cost concepts – FC, VC, TC, MC – Cost output in the short and long run. Depreciation - meaning – Causes – Methods of computing Depreciation (simple problems in Straight Line Method, Written Down Vale Method). Meaning – Break Even Analysis - Managerial uses of BEA.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Ramachandra Aryasri V. V.Ramana Murthy, Engineering Economics & Financial Accounting, Tata McGraw Hill,–,New Delhi, 2016
2. Varshney R. L., and K.L Maheshwari, Managerial Economics, Sultan Chand & Sons, New Delhi, 2015
3. M.L.Jhingan, Principles of Economics, Konark Publications, 2010
4. Prasanna Chandra, Fundamentals of Financial Management, Tata McGraw Hill, New Delhi, 2014
5. D.M.Mithani, Money, Banking, International Trade & Public Finance, Himalaya Publishing House, 2010

19PBEME602 AUTOMATION IN MANUFACTURING SEMESTER – VI
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES:

1. To understand the importance of automation in the of field machine tool basedmanufacturing
2. To get the knowledge of various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics andCNC
3. To understand the basics of product design and the role of manufacturingautomation
4. To provide an overview of importance of group technology andFMS
5. To provide knowledge on various inspection technologies to enhance the quality of thesystem
6. To enrich the understanding of various manufacturing supportsystems

COURSE OUTCOMES

Upon completion of this course, the students will

1. Understand the basics and need for automation inmanufacturing
2. Describe the essential requirement of the computers indesign
3. Explain the importance of group technology andFMS
4. Understand the essentiality of qualitycontrol.
5. Apply various inspection technologies to enhance the quality of thesystem.
6. Explain various manufacturing supportsystems.

UNIT I INTRODUCTION 9

Why automation, Current trends, CAD, CAM, CIM; Rigid automation: Part handling, Machine tools. Flexible automation: Computer control of Machine Tools and Machining Centers, NC and NC part programming, CNC-Adaptive Control, Automated Material handling. Assembly, Flexible fixturing.

UNIT II COMPUTER AIDED DESIGN 9

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

UNIT III COMPUTER AIDED MANUFACTURING 9

Computer Aided Manufacturing: CNC technology, PLC, Micro-controllers, CNC Adaptive Control

UNIT IV LOW COST AUTOMATION 9

Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies

UNIT V MODELING AND SIMULATION 9

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

TOTAL 45 PERIODS

SUGGESTED READINGS:

1. Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing, prentice Hall
2. SeropeKalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology, 7th edition,Pearson
3. YoramKoren, Computer control of manufacturing system, 1st edition
4. Ibrahim Zeid , CAD/CAM : Theory & Practice, 2nd edition

19PBEME6E-	**PROFESSIONAL ELECTIVE - II**	**SEMESTER – VI**
-		**3H: 3C**

19PBEME6E-	**PROFESSIONAL ELECTIVE - III**	**SEMESTER – VI**
-		**3H: 3C**

19PBEME611	**COMPUTER AIDED ANALYSIS LABORATORY**	**SEMESTER – VI**
		3H: 2C

Instruction Hours / Week: - L: 0 T: 0 P: 3 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To gain knowledge in sequence of process planning and cost estimation of various products.
2. To introduce the concepts of dimensional and tolerance analysis
3. To expose students to manufacturing drawings
4. To equip them with skills to apply their knowledge in re-dimensioning and tolerance charting
5. To understand the process chart for a given component
6. To Estimate the cost of a given component

COURSE OUTCOMES

Upon completion of this course, the student can able to

1. Apply the various standards and conventions used in a drawing sheet
2. Perform dimensional and tolerance analysis
3. Understand the manufacturing drawings
4. Apply their knowledge in re-dimensioning and tolerance charting
5. Prepare process chart for a given component
6. Estimate the cost of a given component

LIST OF EXPERIMENTS

Simple Analysis using ANSYS Tool

1. Stress analysis of rectangular L bracket
2. Stress analysis of beams (Cantilever, Simply supported, Fixed ends)
3. Mode frequency analysis of beams (Cantilever, Simply supported, Fixed ends)
4. Harmonic analysis of a 2D component
5. Thermal stress analysis of a 2D component
6. Modeling a 3D component. (Single point cutting tool, I beams, etc.,)

TOTAL 45 PERIODS

19PBEME701 TOTAL QUALITY MANAGEMENT SEMESTER – VII
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVESS

1. To introduce the concepts of essentiality of quality.
2. To understand the importance of various TQM principles.
3. To introduce the concepts of the various TQM principles.
4. To Understand the techniques for quality management.
5. To introduce the standard quality systems in industries.
6. To familiarize the students to understand the various techniques to improve the quality in industries

COURSE OUTCOMES

1. Understand the essentiality of quality.
2. Summarize various TQM principles.
3. Understand the various TQM principles.
4. Understand the techniques for quality management.
5. Implement standard quality systems in industries.
6. Apply various techniques to improve the quality in industries.

UNIT I ESSENTIALS OF TQM 9

Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs – Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

UNIT II TQM PRINCIPLES 9

Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Performance Measures – Basic Concepts, Strategy, Performance Measure.

UNIT III TQM TOOLS 9

The new seven management tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma – APQP.

UNIT IV TQM TECHNIQUES 9

Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA.

UNIT V QUALITY AND ENVIRONMENT SYSTEMS 9

Need for ISO 9000 and Other Quality Systems, ISO 9000:2002 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, TS 16949, ISO 14000 and ISO 18001 – Concept, Requirements and Benefits.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Dale H. Besterfiled, Total Quality Management, 4e, Pearson Education, Delhi, 2015
2. Joseph A. Defeo, Juran's Quality Management and Analysis, 6th Edition, McGraw Hill International, 2015
3. Armand V. Feigenbaum, Total Quality Control, ASQ Quality Press, 2008
4. Oakland.J.S, Total Quality Management, Butterworth – Heinemann Ltd., Oxford, 2003
5. Narayana V. and Sreenivasan N.S, Quality Management – Concepts and Tasks, New Age International Ltd., New Delhi, 2007
6. Zairi, Total Quality Management for Engineers, Wood Head Publishers, New Delhi, 1996

19PBEME7E-	**PROFESSIONAL ELECTIVE – IV**	**SEMESTER – VII**
-		**3H: 3C**

19PBEME7E-	**PROFESSIONAL ELECTIVE - V**	**SEMESTER – VII**
-		**3H: 3C**

19PBEME791	**PROJECT WORK AND VIVA VOCE**	**SEMESTER – VII**
		9H: 6C

Instruction Hours / Week: - L: 0 T: 0 P: 9 Marks: - Internal: 40 External: 60 Total: 100

COURSE OBJECTIVES

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

COURSE DESCRIPTION

The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. 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.

TOTAL 135 PERIODS

PROFESSIONAL ELECTIVES

19PBEME5E01 EMERGING MATERIALS SEMESTER - V
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To describe various processing techniques of different engineering materials.
2. To analyse the Phase diagram and Microstructure using Microscope for different type of Stainless-steel materials.
3. To describe the metallurgical aspects of aluminium, magnesium and titanium alloys.
4. To get basic knowledge on super alloys and its applications
5. To get basic understanding of nano materials, shape memory alloys and biomaterials.
6. To select the material for Biological, Nuclear, Space and Cryogenic service applications.

COURSE OUTCOMES

Upon completion of this course, the students can

1. Describe various processing techniques of different engineering materials.
2. Analyse the Phase diagram and Microstructure using Microscope for different type of Stainless-steel materials.
3. Describe the metallurgical aspects of aluminium, magnesium and titanium alloys.
4. Get basic knowledge on super alloys and its applications
5. Get basic understanding of nano materials, shape memory alloys and biomaterials.
6. Select the material for Biological, Nuclear, Space and Cryogenic service applications
7.

UNIT I **9**

Techniques of rapid solidification. Production of metallic glasses, atomic arrangement, comparison with crystalline alloys - mechanical, electrical, magnetic, superconducting and chemical properties and applications

UNIT II **9**

Phase diagrams of ferritic, martensitic and austenitic stainless steels, duplex stainless steels, precipitation hardenable stainless steels, mechanical and metallurgical properties of stainless steels, HSLA steels, micro-alloyed steels

UNIT III **9**

Aluminium alloys, magnesium alloys and titanium alloys; metallurgical aspects, mechanical properties and applications

UNIT IV **9**

Development of super alloys-iron base, nickel base and cobalt base - properties and their applications; materials for cryogenic service, materials in nuclear field, materials used in space

UNIT V **9**

Carbonaceous materials - including nano tubes and fullerenes; shape memory alloys, functionally gradient materials, high temperature super conductors - bio materials

TOTAL 45 PERIODS

SUGGESTED READINGS

1. SukhDevSehgal, Lindberg R.A., ‘Materials, their Nature, Properties and Fabrication’, S Chand, 1973
2. Polmear I. J. ‘Light alloys: Metallurgy of Light Metals’, 3rd Edition, Arnold, 1995

19PBEME5E02 RENEWABLE ENERGY SOURCES SEMESTER - V
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To explain importance of renewable energy resources.
2. To understand the importance of basic concepts of solar radiation and analyze the working of solar PV and thermal systems.
3. To understand the importance of principles of energy conversion from alternate sources.
4. To understand the importance of wind, geothermal, ocean, biomass, biogas and hydrogen.
5. To study the features of design principles of biogas plants.
6. To understand the concepts and applications of fuel cells, thermoelectric convertor and MHD generator.

To give exposure to power plants working with non-conventional energy.

COURSE OUTCOMES

Upon completion of this course, the students can able to

1. Understand the importance of renewable energy resources.
2. Understand the basic concepts of solar radiation and analyze the working of solar PV and thermal systems.
3. Understand principles of energy conversion from alternate sources.
4. Understand the importance of wind, geothermal, ocean, biomass, biogas and hydrogen.
5. Implement design principles of biogas plants.
6. Understand the concepts and applications of fuel cells, thermoelectric convertor and MHD generator.

UNIT I ENERGY AND ENVIRONMENT 9

Primary energy sources – world energy resources–Indian energy scenario–energy cycle of the earth –environmental aspects of energy utilisation, CO_2 emissions and Global warming–renewable energy resources and their importance. Potential impacts of harnessing the different renewable energy resources.

UNIT II SOLAR ENERGY 9

Principles of solar energy collection – solar radiation – measurements – instruments – data and estimation– types of collectors – characteristics and design principles of different type of collectors – performance of collectors – testing of collectors. Solar thermal applications – water heaters and air heaters – performance and applications – simple calculations – solar cooling – solar drying – solar ponds – solar tower concept – solar furnace.

UNIT III WIND, TIDAL AND GEO THERMAL ENERGY 9

Energy from the wind – general theory of windmills – types of windmills – design aspects of horizontal axis windmills – applications. Energy from tides and waves – working principles of tidal plants and ocean thermal energy conversion plants – power from geothermal energy – principle of working of geothermal power plants.

UNIT IV BIO ENERGY 9

Energy from bio mass and bio gas plants –various types – design principles of biogas plants – applications. Energy from wastes – waste burning power plants – utilization of industrial and municipal wastes – energy from the agricultural wastes.

UNIT V OTHER RENEWABLE ENERGY SOURCES 9

Direct energy conversion (Description, principle of working and basic design aspects only) – Magneto hydrodynamic systems (MHD) – thermoelectric generators – thermionic generators – fuel cells – solar cells – types, Emf generated, power output, losses and efficiency and applications. Hydrogen conversion and storage systems

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Rai G.D, A Non-Conventional Energy sources, Khanna Publishers, New Delhi, 2011
2. John A. Duffie, William A. Beckman, Solar Engineering of Thermal Processes, 4th Edition, John Wiley & Sons, Inc , 2013
3. S. P. Sukhatme and J K Nayak, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw Hill, New Delhi, 2008
4. Garg. H. P and Prakash J, Solar Energy - Fundamentals and applications, Tata McGrawHill, New Delhi, 2000
5. Ashok V Desai, Non–conventional Energy, New Age International (P) Ltd., 2003

19PBEME5E03 ADVANCED IC ENGINES SEMESTER - V
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To understand the underlying principles of operation of different IC Engines and components.
2. To provide knowledge on pollutant formation, control, alternate fueled.
3. To Study and acquire knowledge to Identify parts, terminology and fuel supply system of internal combustion engine
4. To introduce the concepts of cooling and lubrication systems of IC engines
5. To make the student acquire sound knowledge on combustion, knocking and super charging of internal combustion engines
6. To expose students to recent trends associated with IC engines

COURSE OUTCOMES

Upon completion of this course, the students can able to

1. Explain the construction and operation of internal combustion engine.
2. Identify parts, terminology and fuel supply system of internal combustion engine.
3. Recognize the component used in cooling and lubrication systems of IC engines.
4. Describe the function of combustion, knocking and super charging of internal combustion engines.
5. Implement strategies for pollution control.
6. Know about the recent trends associated with IC engines

UNIT I SPARK IGNITION ENGINES 9

Mixture requirements – Fuel injection systems – Monopoint, Multipoint & Direct injection - Stages of combustion – Normal and Abnormal combustion – Knock - Factors affecting knock – Combustion chambers.

UNIT II COMPRESSION IGNITION ENGINES 9

Diesel Fuel Injection Systems - Stages of combustion – Knocking – Factors affecting knock – Direct and Indirect injection systems – Combustion chambers – Fuel Spray behaviour – Spray structure and spray penetration – Air motion - Introduction to Turbocharging.

UNIT III POLLUTANT FORMATION AND CONTROL 9

Pollutant – Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters, Selective Catalytic Reduction and Particulate Traps – Methods of measurement – Emission norms and Driving cycles.

UNIT IV ALTERNATIVE FUELS 9

Alcohol, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel - Properties, Suitability, Merits and Demerits - Engine Modifications.

UNIT V RECENT TRENDS 9

Air assisted Combustion, Homogeneous charge compression ignition engines – Variable Geometry turbochargers – Common Rail Direct Injection Systems - Hybrid Electric Vehicles – NOx Adsorbers - Onboard Diagnostics.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Ramalingam. K.K, Internal Combustion Engine Fundamentals, Scitech Publications, 2002
2. Ganesan, Internal Combustion Engines, 4e, Tata McGraw Hill Education, 2012
3. Mathur. R.B. and R.P. Sharma, Internal Combustion Engines, Dhanpat Rai & Sons, 2007
4. Duffy Smith, Auto Fuel Systems, The Good Heart Willcox Company, Inc., 1987
5. Eric Chowenitz, Automobile Electronics, SAE Publications, 1995

19PBEME5E04 HYDRAULICS AND PNEUMATICS POWER CONTROL SEMESTER - V 3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To recognize symbols and fundamentals in fluid power generation and distribution.
2. To identify power source for hydraulic systems.
3. To select appropriate components used in various hydraulic systems.
4. To design hydraulic circuits for given applications
5. To distinguish the components used in pneumatic circuits.
6. To create the logic circuits for controlling electro-hydraulic/ pneumatic systems.

COURSE OUTCOMES

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

1. Recognize symbols and fundamentals in fluid power generation and distribution.
2. Identify power source for hydraulic systems.
3. Select appropriate components used in various hydraulic systems.
4. Design hydraulic circuits for given applications
5. Distinguish the components used in pneumatic circuits.
6. Create the logic circuits for controlling electro-hydraulic/ pneumatic systems.

UNIT I FLUID POWER SYSTEMS AND FUNDAMENTALS 9

Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, Properties of hydraulic fluids – General types of fluids – Fluid power symbols. Basics of Hydraulics–Applications of Pascals Law– Laminar and Turbulent flow – Reynold's number – Darcy's equation – Losses in pipe, valves and fittings.

UNIT II HYDRAULIC SYSTEM AND COMPONENTS 9

Sources of Hydraulic Power: Pumping theory – Pump classification – Gear pump, Vane Pump, piston pump, Pressure boosting pumps, construction and working of pumps – pump performance – Variable displacement pumps. Fluid Power Actuators: Linear hydraulic actuators – Types of hydraulic cylinders – Single acting, Double acting special cylinders like tanden, Rodless, Telescopic, Cushioning mechanism, Construction of double acting cylinder, Rotary actuators – Fluid motors, Gear, Vane and Piston motors.

UNIT III DESIGN OF HYDRAULIC CIRCUITS 9

Construction of Control Components : Direction control valve – 3/2 way valve – 4/2 way valve – Shuttle valve – check valve – pressure control valve – pressure reducing valve, sequence valve, Flow control valve – Fixed and adjustable, electrical control solenoid valves, Relays, ladder diagram. Accumulators and Intensifiers: Types of accumulators – Accumulators circuits, sizing of accumulators, intensifier – Applications of Intensifier – Intensifier circuit.

UNIT IV PNEUMATIC SYSTEMS AND COMPONENTS 9

Pneumatic Components: Properties of air – Compressors – Filter, Regulator and Lubricator UNIT Air control valves, Quick exhaust valves, pneumatic actuators. Fluid Power Circuit Design, Speed control circuits, synchronizing circuit, Penumo hydraulic circuit, Sequential circuit design for simple applications using cascade method.

UNIT V DESIGN OF PNEUMATIC CIRCUITS 9

Servo systems – Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves. Fluidics – Introduction to fluidic devices, simple circuits, Introduction to Electro Hydraulic Pneumatic logic circuits, ladder diagrams, PLC applications in fluid power control. Fluid power circuits; failure and troubleshooting.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Anthony Esposito, Fluid Power with Applications, Pearson Education, New Delhi, 2013
2. Majumdar S. R, Oil Hydraulic Systems: Principles and Maintenance, Tata McGraw–Hill, New Delhi, 2000
3. Majumdar S. R, Pneumatic systems – Principles and maintenance, Tata McGraw Hill, New Delhi, 1995
4. Anthony Lal, Oil hydraulics in the service of industry, Allied publishers, New Delhi, 1982
5. Michael J, Prinches and AshbyJ.G, Power Hydraulics, Prentice Hall of India, New Delhi, 1996

19PBEME5E05 AUTOMOBILE ENGINEERING SEMESTER - V
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To make the student acquire sound knowledge on the types of vehicle structures, cooling and lubrication systems required.
2. To acquaint the student with the concepts of type of engines to be used for modern automobiles.
3. To familiarize the students to Distinguish between the manual transmissions systems with automatic transmission systems.
4. To provide knowledge on appropriate transmission systems for the optimal power transmission.
5. To provide knowledge on steering, brakes and suspension systems for effective functioning.
6. To acquaint the student with advanced technologies in automotive Engineering.

COURSE OUTCOMES

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

1. Identify the types of vehicle structures, cooling and lubrication systems required.
2. Determine the type of engines to be used for modern automobiles.
3. Distinguish between the manual transmissions systems with automatic transmission systems.
4. Select appropriate transmission systems for the optimal power transmission.
5. Select steering, brakes and suspension systems for effective functioning.
6. Implement the advanced technologies in automotive.

UNIT I AUTOMOBILE ARCHITECTURE AND PERFORMANCE 9

Automotive components, subsystems and their positions- Chassis, frame and body, front, rear and four wheel drives, Operation and performance, Traction force and traction resistance, Power required for automobile-Rolling, air and gradient resistance.

UNIT II TYPES OF ENGINE 9

Types of engine, multi valve engine, in-line engine, vee-engine, Petrol engine-direct, single point and multipoint injection, diesel engine-common rail diesel injection, supercharging and turbo charging, alternate fuels-ethanol and ethanol blend, compressed natural gas, fuel cells, hybrid vehicles.

UNIT III TRANSMISSION SYSTEMS 9

Clutch : Types-coil spring and diaphragm type clutch, single and multi plate clutch, centrifugal clutch, Gear box : Types-constant mesh, sliding mesh and synchromesh gear box, layout of gear box, gear selector and shifting mechanism, overdrive, automatic transmission, Propeller shaft, universal joint, slip joint, differential and real axle arrangement, hydraulic coupling.

UNIT IV WHEEL AND TYRES AND SUSPENSION SYSTEM 9

Types of wheels, construction, wired wheels, Tyres- construction, Radial, bias & belted bias, slip angle, Tread patterns, Tyre retreading cold & hot, Tubeless tyres

Types-front and rear suspension, conventional and independent type suspension, leaf springs, coil springs, dampers, torsion bars, stabilizer bars, arms, air suspension systems– Balancing of Wheels

UNIT V STEERING SYSTEM AND BRAKING SYSTEM 9

Types of steering systems, Ackermann principle, Davis steering gear, steering gear boxes, steering linkages, power steering, wheel geometry-caster, camber toe-in, toe out etc., wheel Alignment and balancing.

Breaking System - Forces on vehicles, tyre grip, load transfer, braking distribution between axles, stopping distance, Types of brakes, Mechanical, Hydraulic, Air brakes, Disc & Drum brakes, Engine brakes anti lock braking system.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Gupta R.B, Automobile Engineering, Laxmi Publications, Chennai, 2004
2. Kirpal Singh, Automobile Engineering Vol–I and II, Standard publishers, Delhi, 2007
3. Julian Happian Smith, An introduction to modern vehicle design, Butterworth Heinemann, New Delhi, 2002
4. Crouse W H, Automotive transmissions and power trains, McGraw–Hill International Editions, New Delhi, 1976

19PBEME6E01 DESIGN OF JIGS, FIXTURES AND PRESS TOOLS SEMESTER - VI 3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To impart knowledge on the principles of locating and clamping devices in machining process.
2. To familiarize the students to understand design of jigs for a given component.
3. To Study and acquire knowledge on design fixtures for a given component.
4. To make the student acquire sound knowledge on appropriate type of press tool for a given component.
5. To expose students to drawing die for a given component.
6. To give exposure to the use computer aids for sheet metal forming analysis

COURSE OUTCOMES

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

1. Summarize the principles of locating and clamping devices in machining process.
2. Design jigs for a given component.
3. Design fixtures for a given component.
4. Design an appropriate type of press tool for a given component.
5. Develop a drawing die for a given component.
6. Use computer aids for sheet metal forming analysis

UNIT I PURPOSE TYPES AND FUNCTIONS OF JIGS AND FIXTURES 9

Tool design objective – Production devices – Inspection devices – Materials used in Jigs and Fixtures – Types of Jigs – Types of Fixtures–Mechanical actuation–pneumatic and hydraulic actuation–Analysis of clamping force–Tolerance and error analysis.

UNIT II JIGS 9

Drill bushes –different types of jigs–plate latch, channel, box, post, angle plate, angular post, turnover, pot jigs–Automatic drill jigs–Rack and pinion operated. Air operated Jigs components. Design and development of Jigs for given components.

UNIT III FIXTURES 9

General principles of boring, lathe, milling and broaching fixtures– Grinding, planning and shaping fixtures, assembly, Inspection and welding fixtures– Modular fixtures. Design and development of fixtures for given component.

UNIT IV PRESS WORKING TERMINOLOGIES AND ELEMENTS OF DIES AND STRIP LAY OUT 9

Press working terminology–Presses and press accessories–Computation of capacities and tonnage requirements. Elements of progressive combination and compound dies:Die block–die shoe. Bolster plate–punch plate–punch holder–guide pins and bushes – strippers – knockouts–stops –pilots–Selection of standard die sets strip lay out–strip lay out calculations

UNIT V DESIGN AND DEVELOPMENT OF DIES 9

Design and development of progressive and compound dies for Blanking and piercing operations. Bending dies – development of bending dies–forming and drawing dies–Development of drawing dies. Design considerations in forging, extrusion, casting and plastic dies.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Edward G Hoffman, Jigs and Fixture Design, Thomson – Delmar Learning, Singapore, 2012
2. Cyril Donaldson, George H. Lecain and V. C. Goold, Tool Design, 4e, Tata McGraw–Hill, New Delhi, 2012
3. Maurice Henry Albert Kempster, Principles of Jig and Tool Design, Hart Publishing Company, 1968
4. Joshi P.H, Jigs and Fixtures, 3e, Tata McGraw–Hill Publishing Company Limited, New Delhi, 2010
5. Hiram E Grant, Jigs and Fixtures: Non-Standard Clamping Devices, 1e, Tata McGraw–Hill, New Delhi, 1971

19PBEME6E02 REFRIGERATION AND AIR CONDITIONING SEMESTER - VI

3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To understand the underlying principles of operations in different Refrigeration & Air conditioning systems and components.
2. To provide knowledge on design aspects of Refrigeration & Air conditioning systems
3. To introduce the concepts on use of unconventional refrigerant system for industrial application
4. To expose students to properties of air using psychrometric chart
5. To provide knowledge on cooling load for a given system
6. To know the application of air conditioning system for industrial and domestic purpose

COURSE OUTCOMES

Learners should be able to

1. Calculate COP of various refrigeration cycles.
2. Choose appropriate refrigerants for various applications.
3. Identify the use of unconventional refrigerant system for industrial application.
4. Calculate the properties of air using psychrometric chart.
5. Calculate cooling load for a given system
6. Select the appropriate air conditioning system for industrial and domestic applications.

UNIT I REFRIGERATION CYCLE 9

Review of thermodynamic principles of refrigeration. Concept of refrigeration system. Vapour compression refrigeration cycle – use of P–H charts – multistage and multiple evaporator systems – cascade system – COP comparison. Vapor absorption refrigeration system. Ammonia water and Lithium Bromide water systems. Steam jet refrigeration system

UNIT II REFRIGERANTS, SYSTEM COMPONENTS AND BALANCING 9

Compressors – reciprocating and rotary (elementary treatment.) – Condensers – evaporators – cooling towers. Refrigerants – properties – selection of refrigerants, Alternate Refrigerants, Refrigeration plant controls – testing and charging of refrigeration units. Balancing of system components. Applications to refrigeration systems – ice plant – food storage plants – milk –chilling plants – refrigerated cargo ships.

UNIT III PSYCHROMETRY 9

Psychrometric processes– use of psychrometric charts – – Grand and Room Sensible Heat Factors – bypass factor – requirements of comfort air conditioning – comfort charts – factors governing optimum effective temperature, recommended design conditions and ventilation standards

UNIT IV COOLING LOAD CALCULATIONS 9

Types of load – design of space cooling load – heat transmission through building. Solar radiation – infiltration – internal heat sources (sensible and latent) – outside air and fresh air load – estimation of total load – Domestic, commercial and industrial systems – central air conditioning systems.

UNIT V AIRCONDITIONING 9

Air conditioning equipments – air cleaning and air filters – humidifiers – dehumidifiers – air washers – condenser – cooling tower and spray ponds – elementary treatment of duct design – air distribution system. Thermal insulation of air conditioning systems. – Applications: car, industry, stores, and public buildings

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Manohar Prasad, Refrigeration and Air Conditioning, New Age International Ltd, New Delhi, 2011
2. Arora. C.P, Refrigeration and Air Conditioning, Tata McGraw–Hill, New Delhi, 2008
3. Roy.J Dossat, Principles of Refrigeration, Prentice Hall of India PVT Ltd., New Delhi, 2001
4. Jordon and Prister, Refrigeration and Air Conditioning, Prentice Hall of India PVT Ltd., New Delhi, 1981
5. Stoecker N.F and Jerold W.Jones, Refrigeration and Air Conditioning, McGraw Hill, New Delhi, 1986

19PBEME6E03 ADVANCED MANUFACTURING PROCESSES SEMESTER - VI

3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To provide knowledge on different aspects of powder metallurgy parameters.
2. To understand the importance of principle of advanced welding processes and its application.
3. To understand the importance of advanced forming processes and its application.
4. To familiarize the students to advanced manufacturing process for processing of different materials.
5. To acquaint the student to apply the suitable rapid prototyping mechanism for industry need.
6. To provide knowledge on optimum parametric for advanced manufacturing process**.**

COURSE OUTCOMES

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

1. Understand different aspects of powder metallurgy parameters.
2. Understand basic principle of advanced welding processes and its application.
3. Understand basic principle of advanced forming processes and its application.
4. Select the best suitable advanced manufacturing process for processing of different materials.
5. Apply the suitable rapid prototyping mechanism for industry need.
6. Select the optimum parametric for advanced manufacturing process.

UNIT I POWDER METALLURGY PROCESS 9

Introduction to powder metallurgy process – preparation of powders – types and functions of binders – green compaction – sintering process and its effect on the product.

UNIT II ADVANCED WELDING PROCESSES 9

Percussion Welding– Electro Slag Welding, Plasma Arc Welding – Thermit Welding – Electron Beam Welding – Friction and Inertia Welding – Friction Stir Welding – Under Water Welding Process.

UNIT III SHEET METAL AND FORMING PROCESS 9

Sheet metal process –Laser welding and Cutting, Working principle and application of special forming process – Hydro Forming– Rubber Pad Forming– Explosive Forming – Magnetic Pulse Forming– Peen Forming – Super Plastic Forming – Deep Drawing Process.

UNIT IV ADVANCED MACHINING PROCESS 9

Modern machining process: Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, Electro chemical Machining, Electro chemical Grinding, Electro Discharge Machining, wire cut EDM, Electron Beam Machining, plasma arc machining, Laser Beam Machining. Ultrasonic Machining, High speed machining process – deep hole drilling process

UNIT V RAPID PROTOTYPING 9

Introduction to Rapid Prototyping – Need for RPT– Stereo–lithography – Selective Laser Sintering, Fused Deposition Modeling, Laminated Object Manufacturing, Solid Ground Curing, Ballistic Particle Manufacturing

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Serope Kalpakjian Steven R. Schmid, Manufacturing process for engineering materials, 2e, Pearson Education, Inc, 2009
2. O. P. Khanna, A Textbook of Welding Technology, Dhanpat Rai Publications Pvt Ltd, 2012
3. P.N. Rao, Manufacturing technology Volume I, 4e, Tata McGraw Hill Education, 2013
4. Singh, M.K, Unconventional Manufacturing Process, New age international, 2010
5. Vijay.K Jain, Advanced Machining Processes, Allied Publishers Pvt. Ltd, 2009

19PBEME6E04 DESIGN AND ANALYSIS OF EXPERIMENTS SEMESTER - VI
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To provide foundations on design of experiments and statistical analysis of experimental data obtained from laboratory and/or industrialprocesses.
2. To understand the important concepts of single factorial designs
3. To Study and acquire knowledge on various methodologies involved in single factorial designs
4. To know the application of testing of factorial experiment
5. To enrich the understanding of special experimental designs
6. To impart knowledge on basic concepts of Taguchi method in parameter design

COURSE OUTCOMES

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

1. Understand the knowledge of various techniques for experimentalplanning
2. Understand the concepts of single factorialdesigns
3. List the various methodologies involved in single factorialdesigns
4. Apply the concept of testing of factorialexperiment
5. Solve the partial and ordinary differential equations special experimentaldesigns
6. Apply the basic concepts of Taguchi method in parameterdesign

UNIT I INTRODUCTION 9

Planning of experiments – Steps – Need - Terminology: Factors, levels, variables, experimental error, replication, Randomization, Blocking, Confounding.

UNIT II SINGLE FACTOR EXPERIMENTS 9

ANOVA rationale - Sum of squares – Completely randomized design, Randomized block design, effect of coding, Comparison of treatment means – Newman Kuel‘s test, Duncan‘s Multiple Range test, Latin Square Design, Graeco-Latin Square Design, Balanced incomplete design.

UNIT III FACTORIAL EXPERIMENTS 9

Main and interaction effects –Two and three Factor full factorial Designs, 2 k deigns with Two and Three factors-Unreplicated design- Yate‘s Algorithm

UNIT IV SPECIAL EXPERIMENTAL DESIGNS 9

Blocking in factorial design, Confounding of 2k design, nested design-Response Surface Methods.

UNIT V TAGUCHI TECHNIQUES 9

Fundamentals of Taguchi methods, Quality Loss function, orthogonal designs, application to Process and Parameter design.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Montgomery, D.C, Design and Analysis of Experiments, John Wiley and Sons, 2012
2. Hicks. C.R, Fundamental concepts in the Design of Experiments, Holt, Rinehort and Winston, 2000
3. Bagchi. T.P, Taguchi Methods explained, PHI, 2002
4. Ross. P.J, Taguchi Techniques for quality Engineering, Prentice Hall, 2000

19PBEME6E05 HYBRID VEHICLE TECHNOLOGY SEMESTER - VI

3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. This course introduces the fundamental concepts, principles, analysis and design of hybrid, electric and fuel cell vehicles.
2. To understand working of different configurations of electric vehicles, and its components, hybrid vehicle configuration and performance analysis.
3. To impart knowledge on various energy source
4. To provide knowledge on concepts of electric propulsion systems
5. To expose students to various drive trains for hybrid electric vehicles
6. To facilitate the understanding of the concepts of electronic converters

COURSE OUTCOMES

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

1. Understand the concepts of electric and hybrid electric vehicles
2. Describe about the various energy source available for the hybrid electric vehicles.
3. Explain the concepts of electric propulsion systems
4. Design series drive train for hybrid electric vehicles
5. Design parallel drive train for hybrid electric vehicles
6. Understand the concepts of electronic converters for battery charging of electric hybrid vehicles

UNIT I ELECTRIC AND HYBRID ELECTRIC VEHICLES 9

Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains

UNIT II ENERGY STORAGE FOR EV AND HEV 9

Energy storage requirements, Battery parameters, Types of Batteries, Modeling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation, Modeling of PEMFC, Super Capacitors.

UNIT III ELECTRIC PROPULSION 9

EV consideration, DC motor drives and speed control, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Configuration and control of Drives

UNIT IV DESIGN OF ELECTRIC AND HYBRID ELECTRIC VEHICLES 9

Series Hybrid Electric Drive Train Design: Operating patterns, control strategies, Sizing of major components, power rating of traction motor, power rating of engine/generator, design of PPS Parallel Hybrid Electric Drive Train Design: Control strategies of parallel hybrid drive train, design of engine power capacity, design of electric motor drive capacity, transmission design, energy storage design

UNIT V POWER ELECTRONIC CONVERTER FOR BATTERY CHARGING 9

Charging methods for battery, Termination methods, charging from grid, The Z-converter, Isolated bidirectional DC-DC converter, Design of Z-converter for battery charging, High frequency transformer based isolated charger topology, Transformer less topology.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. M. Ehsani, Y. Gao, S. Gay and Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design CRC Press 2009
2. Iqbal Husain Electric and Hybrid Vehicles: Design Fundamentals CRC Press 2010
3. Sheldon S. Williamson Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles Springer 2013
4. Ron Hodkinson and John Fenton Light Weight Electric/Hybrid Vehicle Design ButterworthHeinemann 2001
5. Chan.C.C and.Chau.K.T Modern Electric Vehicle Technology OXFORD University Press 2001

19PBEME6E06 DESIGN FOR MANUFACTURE AND ASSEMBLY SEMESTER - VI

3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To understand the importance of the DFM approach and guidelines
2. To enrich the understanding of the selective assembly and Datum systems
3. To introduce the concepts of demonstrate true Position tolerancing theory.
4. To develop an understanding of the standard techniques and redesigning cast members using weldments and plastic component manufacturing.
5. To equip them with skills on Tolerance Charting Technique.
6. To Study and acquire knowledge of the various factors influencing the manufacturability of components and the use of tolerances in manufacturing

COURSE OUTCOMES

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

1. Understand the DFM approach and guidelines
2. Understand the selective assembly and Datum systems
3. Demonstrate true Position tolerancing theory.
4. Understand redesigning cast members using weldments and plastic component manufacturing.
5. Demonstrate the Tolerance Charting Technique.
6. Know the various factors influencing the manufacturability of components and the use of tolerances in manufacturing

UNIT I DFM APPROACH, SELECTION AND SUBSTITUTION OF MATERIALS IN INDUSTRY 9

DFM approach, DFM guidelines, standardisation, group technology, value engineering, comparison of materials on cost basis, design for assembly, DFA index, Poka – Yoke principle; 6σ concept; Tolerance Analysis: Process capability, process capability metrics, Cp, Cpk , cost aspects, feature tolerances, geometric tolerances, surface finish, review of relationship between attainable tolerance grades and different machining process, cumulative effect of tolerances, sure fit law, normal law and truncated normal law.

UNIT II SELECTIVE ASSEMBLY 9

Interchangeable and selective assembly, deciding the number of groups, Model–I: group tolerances of mating parts equal; Model–II: total and group tolerances of shaft, control of axial play.

Datum Systems: Grouped datum systems–different types, two and three mutually perpendicular grouped datum planes, grouped datum system with spigot and recess, pin and hole, and tongue–slot pair, computation of translational and rotational accuracy.

UNIT III TRUE POSITION TOLERANCING THEORY 9

Comparison between co–ordinate and convention method of feature location tolerancing and true position tolerancing, zero true position tolerance, virtual size concept, floating and fixed fasteners, projected tolerance zone, functional gauges, paper layout gauging, compound assembly, examples.

UNIT IV FORM DESIGN OF CASTINGS AND WELDMENTS 9

Redesign of castings based on parting line considerations, minimising core requirements, redesigning cast members using weldments, use of welding symbols – design considerations for plastic component manufacturing.

UNIT V TOLERANCE CHARTING 9

Tolerance Charting Technique: Operation sequence for typical shaft type of components, preparation of process drawings for different operations, tolerance worksheets and centrality analysis, examples, design features to facilitate machining. Datum features – functional and manufacturing, component design–machining considerations, redesign for manufacture, examples.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Harry Peck, Designing for Manufacture, Pitman Publications, London, 1973
2. Gerhard Pahl, Wolfgang Beitz, Engineering Design – A Systematic Approach, Springer Science & Business Media, 2013
3. Spotts M F, Dimensioning and Tolerance for Quantity Production, Prentice Hall Inc., New Jersey, USA, 1983
4. Oliver R Wade, Tolerance Control in Design and Manufacturing, Industrial press Inc., New York, 1967

5. James G Bralla, Hand Book of Product Design for Manufacturing, McGraw Hill Publications, New Delhi, 1986
6. Clyde M. Creveling, Tolerance Design – A Hand Book for Developing Optimal Specifications, Addison Wesley Longman Inc, 1997

19PBEME6E07 COMPUTATIONAL FLUID DYNAMICS SEMESTER - VI
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To introduce Governing Equations of viscous fluidflows
2. To introduce numerical modeling and its role in the field of fluid flow and heattransfer
3. To enable the students to understand the various discretization methods, solution procedures and turbulencemodeling.
4. To create confidence to solve complex problems in the field of fluid flow and heat transfer by using high speedcomputers.
5. To equip them with skills to solve convection and diffusionproblems
6. To understand the importance continuity and momentum equations for different types of fluidflow

COURSE OUTCOMES

Upon completion of this course, the students can able

1. Identify, solve engineering problems by computational fluiddynamics.
2. Understand the importance of governing equations involved inCFD
3. Formulate and solve problems in the field of fluid flow and heattransfer.
4. Solve the heat conduction problems using finite differencemethod.
5. Analyze and provide solutions for convection and diffusionproblems.
6. Develop continuity and momentum equations for different types of fluidflow.

UNIT I GOVERNING EQUATIONS AND BOUNDARY CONDITIONS 9

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time–averaged equations for Turbulent flow – Turbulence –Kinetic –Energy Equations – mathematical behavior of PDEs on CFD: Elliptic, Parabolic and Hyperbolic equations.

UNIT II DISCRETIZATION AND SOLUTION METHODOLOGIES 9

Methods of Deriving the Discretization Equations – Taylor Series formulation – Finite difference method – Control volume Formulation – Spectral method.

Solution methodologies: Direct and iterative methods, Thomas algorithm, Relaxation method, Alternating Direction Implicit method.

UNIT III HEAT CONDUCTION 9

Finite difference and finite volume formulation of steady/transient one–dimensional conduction equation, Source term linearization, Incorporating boundary conditions, Finite volume formulations for two and three dimensional conduction problems

UNIT IV CONVECTION AND DIFFUSION 9

Finite volume formulation of steady one–dimensional convection and Diffusion problems, Central, upwind, hybrid and power–law schemes – Discretization equations for two dimensional convection and diffusion.

UNIT V CALCULATION OF FLOW FIELD 9

Representation of the pressure – Gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and velocity corrections – Pressure – Correction equation, SIMPLE algorithm and its variants. Turbulence models: mixing length model, two equation (k–ε) models.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Versteeg H.K and Malalasekera.W, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2/e, Pearson education, 2008
2. Ghoshdastidar P.S, Computer Simulation of flow and heat transfer, Tata McGraw–Hill Publishing Company Ltd., New Delhi, 1998
3. Patankar S.V, Numerical Heat Transfer and Fluid Flow, CRC press, Taylor & Francis Group, 1980
4. Muralidhar K and Sundarajan T, Computational Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi, 2013
5. BoseT.K. Jain, Numerical Fluid Dynamics, Narosa publishing House, New Delhi, 2005

19PBEME6E08 POWER PLANT ENGINEERING SEMESTER - VI
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To give exposure to accessories and layout required for a steam power plant depending upon the requirements.
2. To study performance of steam power plant.
3. To make the student acquire sound knowledge of working of nuclear and hydel power plant.
4. To study the features of gas turbine power plant.
5. To make the student acquire sound knowledge of economics of the power plant.
6. To make the student acquire sound knowledge on renewable energy technologies and availability.

COURSE OUTCOMES

Upon completion of this course, the students can able to

1. Select the accessories and layout required for a steam power plant depending upon the requirements.
2. Compute performance of steam power plant.
3. Explain the working of nuclear and hydel power plant.
4. Compute performance of gas turbine power plant.
5. Calculate the economics of the power plant.
6. Apply appropriate type of renewable energy technologies depending upon the application and availability.

UNIT I INTRODUCTION TO POWER PLANTS AND BOILERS 9

Introduction to Power Plants – Combined Power Cycles – Comparison and Selection, Load Duration Curves. Steam Boilers and Cycles – High Pressure and Super Critical Boilers – Fluidized Bed Boilers – Industrial Standards.

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UNIT II STEAM POWER PLANT 9

Layout of Steam Power Plant - Fuel and Ash Handling, Combustion Equipment for burning coal, Mechanical Stokers, Pulveriser, Electrostatic Precipitator, Draught – different types, Surface Condenser Types, Cooling Towers

UNIT III NUCLEAR AND HYDEL POWER PLANTS 9

Layout of Nuclear Power Plant - Nuclear Energy – Fission, Fusion Reaction, Types of Reactors, pressurized water reactor, Boiling Water Reactor, Waste Disposal and safety.

Layout of Hydel Power Plant – Essential Elements, Selection of Turbines, Governing of Turbines– Micro Hydel developments.

UNIT IV DIESEL AND GAS TURBINE POWER PLANT 9

Layout of Diesel Power Plant - Types, Components, Selection of Engine Type, Layout of Gas Turbine Power Plant- Applications – Fuels – Gas Turbine Material – Open and Closed Cycles – Reheating – Regeneration and Intercooling – Combined Cycle.

UNIT V OTHER POWER PLANTS AND ECONOMICS OF POWER PLANTS 9

Layout of Geo thermal –OTEC – Tidel – Pumped storage – Solar thermal central receiver system.

Cost of Electric Energy – Fixed and operating Costs – Energy Rates – Types of Tariffs – Economics of load sharing, comparison of economics of various power plants.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Arora S.C and Domkundwar S, A course in Power Plant Engineering, Dhanpatrai Publishers, New Delhi, 2014
2. Nag P.K, Power plant Engineering, Tata McGraw Hill, New Delhi, 2014
3. Rajput R.K, Power Plant Engineering, 5e, Laxmi Publications, Chennai, 2016
4. Morse Frederick T, Power Plant Engineering, Prentice Hall of India, New Delhi, 1998

19PBEME6E09 ADDITIVE NANUFACTURING SEMESTER - VI
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To know the principle methods, areas of usage, possibilities and limitations as well as environmental effects of the Additive Manufacturing technologies
2. To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.
3. To introduce process involved in Additive manufacturing technology
4. To understand the importance of knowledge on software's used in additive manufacturing technology
5. To enrich the understanding of the working of SLS and other techniques
6. To provide an overview of additive manufacturing technology in medical field and bio-stream

COURSE OUTCOMES

On completion of this course, students will be able to

1. Understand the need for additive manufacturing technology
2. Explain the process involved in Additive manufacturing technology
3. Get knowledge on software's used in additive manufacturing technology
4. Describe the working of SLS and other techniques
5. Apply the additive manufacturing technology in medical field
6. Applications of additive manufacturing technology in bio-stream.

UNIT I INTRODUCTION 9

Overview – History - Need-Classification -Additive Manufacturing Technology in product development- Materials for Additive Manufacturing Technology – Tooling - Applications.

UNIT II CAD & REVERSE ENGINEERING 9

Basic Concept – Digitization techniques – Model Reconstruction – Data Processing for Additive Manufacturing Technology: CAD model preparation – Part Orientation and support generation – Model Slicing –Tool path Generation – Software's for Additive Manufacturing Technology: MIMICS, MAGICS.

UNIT III LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS 9

Classification – Liquid based system – Stereolithography Apparatus (SLA)- Principle, process, advantages and applications - Solid based system –Fused Deposition Modeling - Principle, process, advantages and applications, Laminated Object Manufacturing

UNIT IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS 9

Selective Laser Sintering – Principles of SLS process - Process, advantages and applications, Three Dimensional Printing - Principle, process, advantages and applications- Laser Engineered Net Shaping (LENS), Electron Beam Melting.

UNIT V MEDICAL AND BIO-ADDITIVE MANUFACTURING 9

Customized implants and prosthesis: Design and production. Bio-Additive Manufacturing- Computer Aided Tissue Engineering (CATE) – Case studies

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Chua C.K., Leong K.F., and Lim C.S, Rapid prototyping: Principles and applications, World Scientific Publishers, 2010
2. Gebhardt A, Rapid prototyping, Hanser Publications, 2003
3. Frank W. Liou, Rapid Prototyping and Engineering Applications: A Toolbox for Prototype Development, CRC Press, Taylor & Francis group, 2007
4. Kamrani, Ali K., Nasr, Emad Abouel, Rapid Prototyping: Theory and practice, Springer, 2006
5. Peter Hilton, Rapid Tooling: Technologies and Industrial Applications, CRC Press, Taylor & Francis group, 2000

19PBEME6E10 LOGISTICS & SUPPLY CHAIN MANAGEMENT SEMESTER - VI 3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To know the principle methods, areas of usage, possibilities and limitations as well as environmental effects of the Additive Manufacturing technologies
2. To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.

COURSE OUTCOMES

On completion of this course, students will learn about

1. Basics of SCM and logistics
2. Understand the need for inventory management
3. Apply the need for value of information in SCM
4. Describe about the various strategic alliances
5. Explain about the various issues in the international SCM

UNIT I INTRODUCTION TO SUPPLY CHAIN MANAGEMENT 9

Definition, global optimization, Objectives of SCM. Logistics networks– data collection, model and data elevation, solution techniques.

UNIT II INVENTORY MANAGEMENT 9

Introduction, single warehouse, Inventory examples, economic lot size model, effect of demand uncertainty. Risk pooling, centralized and decentralized system, managing inventory in the supply chain, forecasting.

UNIT III VALUE OF INFORMATION 9

Bullwhip effect, information and supply chain technology. Supply chain integration– push, pull and push–pull system. Demand driven strategies, impact of internet on SCM, distribution strategies.

UNIT IV STRATEGIC ALLIANCES 9

Framework for strategic alliance, third party logistics, retailer, supplies partnership, distributor– integration, procurement and out servicing strategies.

UNIT V INTERNATIONAL ISSUES IN SCM 9

Introduction, risks and advantages– design for logistics, supplies integration into to new product development, mass customization. Issues in customer value.
Information technology for SCM: Goals, standardization, infrastructure, DSS for supply chain management.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Simchi – Levi Davi, Kaminsky Philip and Simchi–Levi Edith, Designing and Managing the Supply Chain, Tata M.Graw– Hill Publishing Company Ltd, New Delhi, 2003
2. Sunil Chopra and Peter Meindl, Supply Chain Management – Strategy, Planning and Operation, Prentice Hall, New Delhi, 2013
3. Ayers J.B, Hand book of Supply Chain Management, The St. Lencie press, New Delhi., 2010
4. Raghuram G and Rangaraj N, Logistics and Supply Chain Management: Cases and Concepts, Macmillan, New Delhi, 2009
5. Scharj P.B, Lasen T.S, Managing the global supply chain, Viva Books, New Delhi, 2000
6. Thomas E Vollman, Clay Whybark D, Manufacturing Planning and Control for Supply Chain Management, Tata McGraw–Hill, New Delhi, 2005

19PBEME7E01 GAS DYNAMICS AND JET PROPULSION SEMESTER - VII
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To understand the basic difference between incompressible and compressible flow.
2. To understand the phenomenon of shock waves and its effect on flow. To gain some basic knowledge about jet propulsion and Rocket Propulsion.
3. To introduce the concepts of various conditions of compressible fluid flows
4. To Study and acquire knowledge on performance analysis of subsonic and supersonic inlets, combustors, afterburners and exhaust nozzles
5. To understand the concept of working of various types of rocket engines
6. To study the features of thrust equation for rocket propulsion system

COURSE OUTCOMES

Upon completion of this course, the students can able to

1. Analyze various conditions of compressible fluid flows.
2. Calculate mass flow rate in flow through variable area ducts.
3. Carryout simple performance analysis of subsonic and supersonic inlets.
4. Perform performance analysis of combustors, afterburners and exhaust nozzles.
5. Understand the working of various types of rocket engines
6. Use thrust equation for rocket propulsion system.

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 area ducts – Nozzle and Diffusers –area ratio as a function of Mach number, mass flow rate through nozzles and diffusers, effect of friction in flow through nozzles. Use of Gas tables.

UNIT II FLOW THROUGH DUCTS 9

Flow through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – Variation of flow properties – Isothermal flow with friction in constant area ducts –Use of tables and charts – Generalised gas dynamics.

UNIT III NORMAL AND OBLIQUE SHOCKS 9

Governing equations – Variation of flow parameters across the normal and oblique shocks – Prandtl – Meyer relations – Use of table and charts – Applications.

UNIT IV JET PROPULSION 9

Theory of jet propulsion – Thrust equation – Thrust power and propulsive efficiency – Operation principle, cycle analysis and use of stagnation state performance of ram jet, turbojet, turbofan and turbo prop engines – Aircraft combustors.

UNIT V ROCKET PROPULSION 9

Types of rocket engines – Propellants – Ignition and combustion – Theory of rocket propulsion – solid and liquid propellants, comparison of different propulsion systems .Performance study – Staging – Terminal and characteristic velocity – Applications – Space flights.

TOTAL 45 PERIODS

(Permitted to use standard Gas Tables in the examination)

SUGGESTED READINGS

1. Yahya.S.M, Fundamentals of Compressible flow, New Age International (P) Ltd., New Delhi, 2009
2. Rathakrishnan.E, Gas Dynamics, Prentice Hall of India, New Delhi, 2017
3. Patrick.H.Oosthvizen, Willam E.Carscallen, Introduction to Compressible fluid flow, CRC press, 2013
4. Zucker,R.D. and Biblarz,O, Fundamentals of Gas Dynamics, John Wiley & Sons, 2002
5. Ganesan .V, Gas Turbines, Tata McGraw–Hill, New Delhi, 2010
6. Philip Graham Hill, Carl R. Peterson, Mechanics and Thermodynamics of Propulsion, Addison –Wesley Publishing Company, 2009

19PBEME7E02 PRODUCTION PLANNING AND CONTROL SEMESTER - VII
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To impart knowledge of need for planning and control in various aspects.
2. To develop an understanding of the standard techniques in various work study methodologies.
3. To familiarize the students to understand the product and process plan.
4. To introduce the concepts of a production schedule based on different facets.
5. To enrich the understanding of the level of inventory
6. To understand the importance the recent advancements in production planning and control.

COURSE OUTCOMES

Student will be able to

1. Indicate the need for planning and control in various aspects.
2. Understand various work study methodologies.
3. Construct product and process plan.
4. Prepare a production schedule based on different facets.
5. Estimate the level of inventory
6. Understand the recent advancements in production planning and control.

UNIT I INTRODUCTION 9

Objectives: and benefits of planning and control–Functions of production control–Types of production–job– batch and continuous–Product development and design–Marketing aspect – Functional aspects–Operational aspect–Durability and dependability aspect–aesthetic aspect. Profit consideration–Standardization, Simplification and specialization–Break even analysis–Economics of a new design.

UNIT II WORK STUDY 9

Method study, basic procedure–Selection–Recording of process – Critical analysis, Development – Implementation – Micro motion and memo motion study – work measurement – Techniques of work measurement – Time study – Production study – Work sampling – Synthesis from standard data – Predetermined motion time standards.

UNIT III PRODUCT PLANNING AND PROCESS PLANNING 9

Product planning–Extending the original product information–Value analysis–Problems in lack of product planning–Process planning and routing–Pre requisite information needed for process planning–Steps in process planning–Quantity determination in batch production–Machine capacity, balancing–Analysis of process capabilities in a multi product system.

UNIT IV PRODUCTION SCHEDULING 9

Production Control Systems–Loading and scheduling–Master Scheduling–Scheduling rules–Gantt charts–Perpetual loading–Basic scheduling problems – Line of balance – Flow production scheduling–Batch production scheduling–Product sequencing – Production Control systems–Periodic batch control–Material requirement planning Kanban –Dispatching–Progress reporting and expediting–Manufacturing lead time–Techniques for aligning completion times and due dates.

UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC 9

Inventory control–Purpose of holding stock–Effect of demand on inventories–Ordering procedures.
Two bin system –Ordering cycle system–Determination of Economic order quantity and economic lot size–ABC analysis–Recorder procedure–Introduction to computer integrated production planning systems–elements of JIT Systems–Fundamentals of MRP and ERP, KANBAN system

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Martand Telsang, Industrial Engineering and Production Management, S.Chand and Company, New Delhi, 2006
2. Samson Eilon, Elements of production planning and control, Macmillan, India, 1981
3. Elwood S.Buffa, and Rakesh K.Sarin, Modern Production Operations Management, John Wiley and Sons, New Delhi, 2007
4. Jain C.K and Aggarwal L.N, Production Planning Control and Industrial Management, Khanna Publishers, New Delhi, 1997

19PBEME7E03 MACHINE TOOL DESIGN SEMESTER - VII

3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVE

1. To gain knowledge in design and material selection of various machinetools.
2. To provide an overview of regulation of speeds and feeds
3. To study the features of machine toolstructures
4. To understand the importance of constructional features of machine toolstructures
5. To expose students to design in machine tool structures, guide ways, power screws andspindles
6. To expose students to design spindles and spindlesupports

COURSE OUTCOMES:

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

1. Discuss the basics machine tool drives andmechanisms
2. Get knowledge on regulation of speeds and feeds
3. Understand the importance of machine toolstructures
4. Explain the constructional features of machine toolstructures
5. Design in machine tool structures, guide ways, power screws andspindles
6. Design spindles and spindlesupports

UNIT I INTRODUCTION TO MACHINE TOOL DRIVES AND MECHANISMS 9

Introduction to the course, Working and Auxiliary Motions in Machine Tools, Kinematics of Machine Tools, Motion Transmission

UNIT II REGULATION OF SPEEDS AND FEEDS 9

Aim of Speed and Feed Regulation, Stepped Regulation of Speeds, Multiple Speed Motors, Ray Diagrams and Design Considerations, Design of Speed Gear Boxes, Feed Drives, Feed Box Design

UNIT III DESIGN OF MACHINE TOOL STRUCTURES 9

Functions of Machine Tool Structures and their Requirements, Design for Strength, Design for Rigidity, Materials for Machine Tool Structures, Machine Tool Constructional Features, Beds and Housings, Columns and Tables, Saddles and Carriages

UNIT IV DESIGN OF GUIDEWAYS, POWER SCREWS AND SPINDLES 9

Functions and Types of Guideways, Design of Guideways, Design of Aerostatic Slideways, Design of Anti-Friction Guideways, Combination Guideways, Design of Power Screws.

UNIT V DESIGN OF SPINDLES AND SPINDLE SUPPORTS 9

Functions of Spindles and Requirements, Effect of Machine Tool Compliance on Machining Accuracy, Design of Spindles, Antifriction Bearings. Dynamics of Machine Tools - Machine Tool Elastic System, Static and Dynamic Stiffness

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Sen, G.C. and Bhattacharya, A, Principles of machine tools, New Central Book Agency, Calcutta, 2006
2. Chernov N, Machine Tools, Mir publishers Moscow, 1984
3. N.K. Mehta, Machine Tool Design and Numerical Control, 3e, TMH, New Delhi, 2012
4. D. K Pal, S. K. Basu, Design of Machine Tools, Oxford IBH, 2008
5. N. S. Acherkhan, Machine Tool Design, MIR publications, 1968

19PBEME7E04 COMPUTER INTEGRATED MANUFACTURING SEMESTER - VII

3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To understand the application of computers in various aspects of Manufacturing viz., Design, proper planning, Manufacturing cost, Layout & Material Handling system.
2. To know the application of principles of group technology in computer aided process planning.
3. To impart knowledge on working of the shop floor control
4. To Study and acquire knowledge on data collection system in FMS.
5. To familiarize the students to understand CIM architecture for practical application.
6. To expose students to generate database for computer integrated manufacturing processes.

COURSE OUTCOMES

Upon completion of this course, the student can able to

1. Implement computer integrated manufacturing concepts in industries.
2. Apply the principles of group technology in computer aided process planning.
3. Understand the working of the shop floor control
4. Implement automated data collection system in FMS.
5. Develop CIM architecture for practical application.
6. Generate database for computer integrated manufacturing processes

UNIT I INTRODUCTION 9

The meaning and origin of CIM– the changing manufacturing and management scene – External communication – islands of automation and software–dedicated and open systems–manufacturing automation protocol – product related activities of a company– marketing engineering – production planning – plant operations – physical distribution– business and financial management.

UNIT II GROUP TECHNOLOGY 9

Group technology– – part families – Classification and coding – Approaches to computer aided process planning –variant approach and generative approaches

UNIT III SHOP FLOOR CONTROL AND INTRODUCTION OF FMS 9

Shop floor control–phases –factory data collection system –automatic identification methods– Bar code technology– automated data collection system. FMS–components of FMS – types –FMS workstation –material handling and storage systems– FMS layout –computer control systems–application and benefits.

UNIT IV CIM IMPLEMENTATION AND DATA COMMUNICATION 9

CIM and company strategy – system modeling tools –IDEF models – activity cycle diagram – CIM open system architecture (CIMOSA)– manufacturing enterprise wheel–CIM architecture – Product data management–CIM implementation software. Communication fundamentals– local area networks –topology – LAN implementations – network management and installations –MRP, ERP concepts

UNIT V OPEN SYSTEM AND DATABASE FOR CIM 9

Open systems–open system inter connection – manufacturing automations protocol and technical office protocol (MAP /TOP).

Development of databases –database terminology– architecture of database systems–data modeling and data associations – relational data bases – database operators – advantages of data base and relational database.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Mikell.P.Groover, Automation, Production Systems and computer integrated manufacturing, 4e, Pearson Education, Delhi, 2016
2. Yoram koren, Computer control of manufacturing systems, 1e, McGraw-Hill, New York, 2005
3. Kant Vajpayee S, Principles of computer-integrated manufacturing, Prentice Hall India, New Delhi, 2003
4. Radhakrishnan P and Subramanyan S , CAD/CAM/CIM, 2e, New Age International (P) Ltd, New Delhi, 2011

19PBEME7E05 ADVANCED WELDING TECHNOLOGY SEMESTER - VII

3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To enable the students to gain competence in various Welding Technologies and to have in depth understanding of the weld ability of metals.
2. To expose students to Identify suitable reinforcement and matrix materials for preparation of composites using friction stir processing.
3. To understand the basic principle of electron beam and laser beam processes and its application.
4. To understand the weld ability of cast iron and high carbon steel.
5. To provide knowledge on welding power sources.
6. To facilitate the understanding of grain growth mechanism and related properties.

COURSE OUTCOMES

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

1. Understand solid state welding processes and applications.
2. Identify suitable reinforcement and matrix materials for preparation of composites using friction stir processing.
3. Understand basic principle of electron beam and laser beam processes and its application.
4. Understand weldability of cast iron and high carbon steel.
5. Select welding power ources.
6. Understand the importance of grain growth mechanism and related properties.

UNIT I SOLID STATE WELDING 9

Solid state welding: classification of solid state welding processes, Adhesive bonding , advantages and applications.

UNIT II FRICTION AND FRICTION STIR WELDING 9

Friction welding: Friction welding process variables, welding of similar and dissimilar materiasl, Defective analysis of friction welded components, Friction welding of materials with inter layer.
Friction stir welding: Processes parameters, tool geometry, welding of Aluminium alloys, Friction stir welding of Aluminum alloys and Magnesium alloys.

UNIT III ELECTRON BEAM WELDING 9

Electron Beam welding (EBW): Electron Beam welding process parameters, atmospheric affect Defective analysis of Electron beam welds and Electron Beam welding dissimilar materials.

UNIT IV LASER BEAM WELDING 9

Laser Beam welding (LBW): Laser Beam welding process parameters, atmospheric affect and Laser Beam welding of steels.

UNIT V SELECTION POWER SOURCE AND WELDABILITY 9

Selection power source : Constant voltage and constant current power sources. Weldability of cast iron and steel : weldability studies of cast iron and steel

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Nadkarni S.V., Modern Welding Technology, Oxford IBH Publishers, 1996.
2. Parmar R. S., Welding Engineering and Technology, Khanna Publishers, 2005.
3. D. L. Olson, T. A. Siewert, Metal Hand Book, Vol 06, Welding, Brazing and Soldering, ASM International Hand book Metals Park, Ohio USA, 2008.

19PBEME7E06 COMPOSITE MATERIALS SEMESTER - VII

3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To understand the fundamentals of composite material strength and its mechanical behavior
2. Understanding the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.
3. Thermo-mechanical behavior and study of residual stresses in Laminates during processing.
4. Implementation of Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronic chips.
5. To introduce the concepts of carbon-carbon composite for different industrial application
6. To impart knowledge on various advances in composites

COURSE OUTCOMES

Learners should be able to

1. Select the various types of composite matrix required for an application.
2. Choose appropriate manufacturing process for polymer matrix composite.
3. Opt appropriate manufacturing process for metal matrix composite.
4. Use the concepts of ceramic composites and its production techniques.
5. Identify the type of carbon-carbon composite for different industrial application.
6. Explain the various advances in composites

UNIT I INTRODUCTION TO COMPOSITES 9

Fundamentals of composites - need for composites – Enhancement of properties - classification of composites – Matrix- Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Reinforcement – Particle reinforced composites, Fibre reinforced composites. Applications of various types of composites.

UNIT II POLYMER MATRIX COMPOSITES 9

Polymer matrix resins – Thermosetting resins, thermoplastic resins – Reinforcement fibres – Rovings – Woven fabrics – Non woven random mats – various types of fibres. PMC processes - Hand lay up processes – Spray up processes – Compression moulding – Reinforced reaction injection moulding - Resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Fibre reinforced plastics (FRP), Glass fibre reinforced plastics (GRP).

UNIT III METAL MATRIX COMPOSITES 9

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

UNIT IV CERAMIC MATRIX COMPOSITES 9

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

UNIT V ADVANCES IN COMPOSITES 9

Carbon /carbon composites – Advantages of carbon matrix – limitations of carbon matrix Carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Sol gel technique. Composites for aerospace applications.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Mathews F.L and Rawlings R.D, Composite Materials: Engineering and Science, Wood head publishing Ltd, England, 1999
2. Chawla K.K, Composite materials: Science and Engineering, Springer Science & Business Media, 2013
3. Clyne T.W and Withers P.J, Introduction to Metal Matrix Composites, Cambridge University Press, New York, 1995
4. Strong A.B, Fundamentals of Composite Manufacturing, Society of Manufacturing Engineering, 2008
5. Sharma S.C, Composite materials, Narosa Publications, New Delhi, 2000

19PBEME7E07 QUALITY CONTROL AND RELIABILITY ENGINEERING SEMESTER - VII 3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To Understand the concept of SQC.
2. To enrich the understanding of control charts to analyze for improving the process quality.
3. To familiarize the students to understand different sampling plans
4. To Understand the importance of need and types of life testing.
5. To introduce the reliability of a system.
6. To introduce the concepts of quality control and reliability techniques in industries.

COURSE OUTCOMES

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

1. Understand the concept of SQC.
2. Use control charts to analyze for improving the process quality.
3. Describe different sampling plans
4. Understand the need and types of life testing.
5. Improve the reliability of a system
6. Implement quality control and reliability techniques in industries

UNIT I INTRODUCTION AND PROCESS CONTROL FOR VARIABLES 9

Introduction, definition of quality, basic concept of quality, definition of SQC, benefits and limitation of SQC, Quality assurance, Quality cost–Variation in process– factors – process capability – process capability studies and simple problems – Theory of control chart– uses of control chart – Control chart for variables – X chart, R chart and σ chart.

UNIT II PROCESS CONTROL FOR ATTRIBUTES 9

Control chart for attributes –control chart for proportion or fraction defectives – P chart and NP chart – control chart for defects – C and U charts, State of control and process out of control identification in charts.

UNIT III ACCEPTANCE SAMPLING 9

Lot by lot sampling – Types – probability of acceptance in single, double, multiple sampling techniques – O.C. curves – producer's Risk and consumer's Risk. AQL, LTPD, AOQL concepts–standard sampling plans for AQL and LTPD– uses of standard sampling plans.

UNIT IV LIFE TESTING – RELIABILITY 9

Life testing – objective: – failure data analysis, Mean failure rate, mean time to failure, mean time between failure, hazard rate, system reliability, series, parallel and mixed configuration – simple problems. Maintainability and availability – simple problems. Acceptance sampling based on reliability test – O.C Curves.

UNIT V QUALITY AND RELIABLITY 9

Reliability improvements – techniques– use of Pareto analysis – design for reliability – redundancy unit and standby redundancy – Optimization in reliability – Product design – Product analysis – Product development – Product life cycles – Maintenance.

TOTAL 45 PERIODS

Note: Permitted to use approved statistical table in the examination.

SUGGESTED READINGS

1. Eugene Grant and Richard Leavenworth, Statistical Quality Control, Tata McGraw–Hill, New Delhi, 2000
2. Srinath L.S, Reliability Engineering, Affiliated East west press New Delhi, 2002
3. Manohar Mahajan, Statistical Quality Control, Dhanpat Rai and Sons, New Delhi, 2003
4. Gerald M. Smith, Statistical Process Control and Quality Improvement, 5th Edition, Pearson Int, 2004
5. Danny Samson, Manufacturing and Operations Strategy, Prentice Hall, New Delhi, 1991
6. Patrick D. T. O'Connor, Practical Reliability Engineering, 4e, John Wiley, New Delhi, 2008

19PBEME7E08 NON DESTRUCTIVE TESTING SEMESTER - VII 3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To provide in-depth knowledge on various techniques of non-destructive testing
2. To provide an overview of destructive and non destructive tests and state their applications
3. To study the features of NDT techniques for various products.
4. To expose students to skills needed for selection of appropriate NDT technique(s) for new inspection jobs
5. To understand the established NDE techniques and basic familiarity of emerging NDE techniques.
6. To facilitate the understanding of standard application area of NDET

COURSE OUTCOMES

Student will be able to

1. Understand the codes, standards and specifications related to NDT
2. Classify the destructive and non destructive tests and state their applications
3. Develop NDT techniques for various products.
4. Acquire skills needed for selection of appropriate NDT technique(s) for new inspection jobs
5. Acquire sound knowledge of established NDE techniques and basic familiarity of emerging NDE techniques.
6. Make use of standards application area of NDET

UNIT I INTRODUCTION 9

Properties of Materials – Characteristics of Ferrous, Non-ferrous and Alloys. Destructive testing and Non-destructive testing – Classification – Uses and applications. Codes, Standards and Specifications(ASME, ASTM, AWS etc.).

UNIT II PENETRANT TESTING AND MAGNETIC PARTICLE INSPECTION 9

Introduction to Penetrant Testing – Liquid Penetrants and Dye Penetrants - An Illustration of Penetrant Testing, Advantages of Penetrants Testing, Disadvantages of Penetrant Testing. Introduction to Magnetic Particle Inspection - An Illustration of Magnetic Particle Inspection, Advantages of Magnetic Particle Crack Detection, Disadvantages of Magnetic Particle Crack Detection

UNIT III ULTRASONIC FLAW DETECTION AND RADIOGRAPHY INSPECTION 9

Introduction to Ultrasonic Flaw Detection ,An Illustration of Ultrasonic Flaw Detection , Advantages of Ultrasonic Flaw Detection, Disadvantages of Ultrasonic Flaw Detection, Principle of Radiography Inspection, Radiation sources, Attenuation in the specimen, Radiographic imaging, Inspection Techniques, Application and limitations, Safety.

UNIT IV EDDY CURRENT AND ELECTRO-MAGNETIC METHODS 9

Introduction to Eddy Current Testing. An Illustration of Eddy Current Testing Equipment , Advantages of Eddy Current Testing, Disadvantages of Eddy Current Testing

UNIT V NON-DESTRUCTIVE INSPECTION(NDI) AND ITS APPLICATIONS 9

Inspection of Raw Products, Inspection For In-Service Damage, Power Plant Inspection, Storage Tank Inspection, Aircraft Inspection, Jet Engine Inspection, Pressure Vessel Inspection, Bridge Inspection, Pipeline Inspection.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Louis Cartz, Nondestructive Testing, ASM International, Almere, Netherland, 1995
2. Paul E. Mix, Introduction to Nondestructive Testing, John Wiley & Sons,Newyork., 2005
3. Baldev Raj, T. and Jayakumar, M. , Practical Non-destructive Testing, Woodhead Publishing, Cambridge., 2007
4. J. Blitz, G. Simpson, Ultrasonic Methods of Non-destructive Testing, Springer Science & Business Media, 1996

19PBEME7E09 INDUSTRIAL SAFETY ENGINEERING SEMESTER - VII 3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To provide in-depth knowledge on various techniques of non-destructive testing
2. To acquaint the student with the need and awareness of the safety concepts
3. To understand the importance of various safety techniques involved in industrial sector
4. To introduce the concepts of accident zone and prepare reports related to it.
5. To equip them with skills to conduct basic safety inspections using strategies that they have developed
6. To develop an understanding of safety monitoring

COURSE OUTCOMES

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

1. Understand the need and awareness of the safety concepts
2. Understand the various safety techniques involved in industrial sector
3. Record and investigate the accident zone and prepare reports related to it.
4. Conduct basic safety inspections using strategies that they have developed
5. Identify and demonstrate working of safety monitoring
6. Train about the education and training based on safety

UNIT I CONCEPTS 9

Evolution of modern safety concept- Safety policy - Safety Organization - line and staff functions for safety- Safety Committee- budgeting for safety.

UNIT II TECHNIQUES 9

Incident Recall Technique (IRT), disaster control, Job Safety Analysis (JSA), safety survey, safety inspection, safety sampling, Safety Audit.

UNIT III ACCIDENT INVESTIGATION AND REPORTING 9

Concept of an accident, reportable and non reportable accidents, unsafe act and condition – principles of accident prevention, Supervisory role- Role of safety committee – Accident causation models - Cost of accident. Overall accident investigation process - Response to accidents, India reporting requirement, Planning document, Planning matrix, Investigators Kit, functions of investigator, four types of evidences, Records of accidents, accident reports

UNIT IV SAFETY PERFORMANCE MONITORING 9

Reactive and proactive monitoring techniques - Permanent total disabilities, permanent partial disabilities, temporary total disabilities -Calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety "t" score, safety activity rate – problems.

UNIT V SAFETY EDUCATION AND TRAINING 9

Importance of training-identification of training needs-training methods – programme, seminars, conferences, competitions – method of promoting safe practice - motivation – communication - role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Accident Prevention Manual for Industrial Operations", N.S.C.Chicago, 1982
2. Heinrich H.W. "Industrial Accident Prevention", McGraw-Hill Company, New York, 1980.
3. Krishnan N.V. "Safety Management in Industry", Jaico Publishing House, Bombay, 1997.
4. John Ridley, "Safety at Work", Butterworth & Co., London, 1983.
5. Roland P. Blake , "Industrial Safety" Prentice Hall, Inc., New Jersey, 1973
6. L M Deshmukh, "Industrial safety management", TATA McGraw Hill, 2010

19PBEME7E10 INDUSTRIAL ROBOTICS SEMESTER - VII
3H: 3C

Instruction Hours / Week: - L: 3 T: 0 P: 0 Marks: - Internal: 40 External: 60 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To understand the anatomy, basic concepts and applications of robot.
2. To learn the drives and end effectors used in robot.
3. To study the various types of sensors used in robot.
4. To familiarize robot kinematics and robot programming
5. To provide knowledge on simple offline robot program
6. To impart knowledge on economic analysis of robots

COURSE OUTCOMES

Upon completion of this course, the students can able to

1. Identify the various types of robots.
2. Select appropriate drive systems and end effectors for industrial application.
3. Decide the types of sensors required according to the applications of robot.
4. To identify the different types of machine vision technologies
5. Develop simple offline robot program for different applications.
6. Calculate the economic analysis of robots.

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 Motor, 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 (Triangulation Principle, Structured, Lighting Approach, Time of Flight Range Finders, Laser Range Meters), Proximity Sensors (Inductive, Hall Effect, Capacitive, Ultrasonic and Optical Proximity Sensors), 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 Differences; Forward Kinematics and Reverse Kinematics of Manipulators with Two, Three Degrees of Freedom (In 2 Dimensional), Four Degrees of Freedom (In 3 Dimensional) – Deviations and Problems.

Teach Pendant Programming, Lead through programming, Robot programming Languages – VAL Programming – Motion Commands, Sensor Commands, End effecter 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 – Pay back Method, EUAC Method, Rate of Return Method, Process application of Robots and Collaborative robots.

TOTAL 45 PERIODS

SUGGESTED READINGS

1. Nicholas O, Mitchell W, Mikell Groover, Roger N Nagel and Ashish Dutta, Industrial Robotics – Technology Programming and Applications, McGraw–Hill, New Delhi, 2012
2. Fu.K.S., Gonzalz.R.C. and Lee C.S.G, Robotics Control, Sensing, Vision and Intelligence, McGraw–Hill Book Co., New Delhi, 2008

3. Yoram Koren, Robotics for Engineers, McGraw–Hill Book Co., New Delhi, 2007
4. Janakiraman. P.A, Robotics and Image Processing: An Introduction, Tata McGraw–Hill, New Delhi, 1995