ME1501	MECHANICS OF MACHINES – II	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT I FORCE ANALYSIS 9

Dynamic force analysis – Inertia force and Inertia torque– D Alembert's principle –Dynamic Analysis in reciprocating engines – Gas forces – Inertia effect of connecting rod– Bearing loads – Crank shaft torque – Turning moment diagrams –Fly Wheels – Flywheels of punching presses

UNIT II BALANCING 9

Static and dynamic balancing – Balancing of rotating masses – Balancing a single cylinder engine –Balancing of Multi-cylinder inline, V-engines – Partial balancing in engines —Balancing machines-Field balancing of discs and rotors

UNIT III FREE VIBRATION 9

Basic features of vibratory systems – Degrees of freedom – single degree of freedom – Free vibration– Equations of motion – Natural frequency – Types of Damping – Damped vibration– Torsional vibration of shaft – Critical speeds of shafts-Torsional vibration of two rotor system

UNIT IV FORCED VIBRATION 9

Response of one degree freedom systems to periodic forcing – Harmonic disturbances – Disturbance caused by unbalance – Support motion –transmissibility – Vibration isolation. Vibration Measurement Instruments

UNIT V MECHANISM FOR CONTROL 9

Governors – Porter, Proell and Hartnell Governor – Characteristics – Effect of friction – Controlling force curves. Gyroscopes – Gyroscopic forces and torques – Gyroscopic stabilization – Gyroscopic effects in Automobiles, ships and airplanes.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Calculate static and dynamic forces of mechanisms.
- Calculate the balancing masses and their locations of reciprocating and rotating masses.
- Compute the frequency of free vibration.
- Compute the frequency of forced vibration and damping coefficient.
- Calculate the speed and lift of the governor
- Estimate the gyroscopic effect on automobiles, ships and airplanes.

TEXT BOOKS:

1. Rattan, S.S, "Theory of Machines", 4 th Edition, Tata McGraw-Hill, 2014.
2. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", 4 th Edition, Oxford University Press, 2014.

REFERENCES:

1. Cleghorn. W. L, "Mechanisms of Machines", Oxford University Press, 2014
2. Ghosh. A and Mallick, A.K., "Theory of Mechanisms and Machines", 3 rd Edition Affiliated East-West Pvt. Ltd., New Delhi, 2006.
3. Rao.J.S. and Dukkipati.R.V. "Mechanisms and Machine Theory", Wiley-Eastern Ltd., New Delhi, 1992.
4. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009.
5. V.Ramamurthi, "Mechanics of Machines", Narosa Publishing House, 2002.
6. Sadhu Singh "Theory of Machines" Pearson Education, 2002.
7. Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 1984.
8. Khurmi, R.S.,"Theory of Machines", 14th Edition, S Chand Publications, 2005.

STANDARDS:

1. IS 11717: 2000, Vocabulary on Vibration and Shock
2. IS 13301: 1992, Guidelines for vibration isolation for machine foundations
3. IS 10000: Part 7: 1980, Methods of tests for internal combustion engines: Part 7 Governing tests for constant speed engines and selection of engines for use with electrical generators
4. IS 13274: 1992, Mechanical vibration - Balancing – Vocabulary
5. IS 13277 : 1992, Balancing machine - Description and evaluation

ME 1502	METROLOGY AND COMPUTER AIDED INSPECTION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide knowledge on various Metrological equipment available to measure the dimension of the components.
- To provide knowledge on the correct procedure to be adopted to measure the dimension of the components.

UNIT I BASICS OF METROLOGY 5

Introduction to Metrology – Need for measurement – Dimensional and Form tolerances – Elements – Work piece, Instruments – Persons – Environment –their effect on Precision and Accuracy – Errors in Measurements – Causes & Types – Control – Types of standards & Practice.

UNIT II LINEAR AND ANGULAR MEASUREMENTS 10

Linear Measuring Instruments – Evolution – Types – Classification – Limit gauges – gauge design – terminology – procedure – concepts of interchange ability and selective assembly – Angular measuring instruments – Types – Bevel protractor, Angle gauges, Sine bar – Angle alignment telescope – Autocollimator – Applications.

UNIT III FORM AND LASER MEASUREMENT 10

Principles and Methods of straightness – Flatness measurement – Thread measurement, gear measurement, surface finish measurement, Roundness measurement – Applications. Use of Lasers – Principle – Laser Interferometer– Application in Linear and Angular measurements – Testing of machine tools using Laser Interferometer.

UNIT IV CO-ORDINATE MEASURING MACHINE AND MACHINE VISION 10

Co-ordinate measuring machine (CMM) – Contact type CMM – Configurations, parts and its features, types of probes, probe compensation. Non-Contact type CMM – Features, probes, Specifications. Errors in CMM measurement, Machine vision system – Methods for sensing objects, image processing, segmentation, pattern recognition – Image histogram and processing

UNIT V MEASUREMENT OF FLOW, PRESSURE AND TEMPERATURE 10

Measurement of Flow: Differential Pressure Meters, Rotameters, Turbine Meters, Electromagnetic Flow meters, Ultrasonic Flow meters. Measurement of Pressure: Dead-Weight Tester, Bourdon-tube pressure gauges, Diaphragm and Bellows. Measurement of Temperature: Bimetallic strip, Resistance Temperature Detectors, Thermistor, Thermocouples, Pyrometers.

TOTAL: 45 PERIODS

OUTCOMES:

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

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

TEXT BOOKS:

1. Jain R.K. “Engineering Metrology”, Khanna Publishers, 19th Edition, 2005.
2. Gupta. I.C., “Engineering Metrology”, Dhanpatrai Publications, 2005.

REFERENCES:

1. Charles Reginald Shotbolt, “Metrology for Engineers”, 5th edition, Cengage Learning EMEA, 1990.
2. Beckwith, Marangoni, Lienhard, “Mechanical Measurements”, Pearson Education , 2006.
3. Galyer J.F.W. and Shotbolt C.R., “Metrology for Engineers”, O.R.Cassel, London,1993.
4. Thomas, “Engineering Metrology”, Butthinson & Co., 1984.

5. Bewoor A.K. and Kulkarni V.A., “Metrology and Measurements”, Tata McGraw-Hill, 2009.
6. Whitehouse D.J., The Handbook of Surface and Nanometrology, CRC Press, 2011

ME1503	DESIGN OF MACHINE ELEMENTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To familiarize the various steps involved in the Design Process
- To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
- To learn to use standard practices and standard data
- To learn to use catalogues and standard machine components
  (Use of P S G Design Data Book is permitted)

UNIT I STATIC STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS 9

Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers – Calculation of principle stresses for various load combinations, eccentric loading – curved beams – crane hook and ‘C’ frame- Factor of safety - theories of failure – Design based on strength and stiffness – stress concentration – Design for variable loading.

UNIT II SHAFTS AND COUPLINGS 9

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

UNIT III TEMPORARY AND PERMANENT JOINTS 9

Threaded fasteners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints for structures - theory of bonded joints.

UNIT IV ENERGY STORING ELEMENTS 9

Various types of springs, optimization of helical springs - Flywheels considering stresses in rims and arms for engines and punching machines.

UNIT V BEARINGS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

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

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

TEXT BOOKS:

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

REFERENCES:

1. Alfred Hall, Halowenko, A and Laughlin, H., “Machine Design”, Tata McGraw-Hill BookCo.(Schaum’s Outline), 2010
2. Ansel Ugural, “Mechanical Design – An Integral Approach", 1st Edition, Tata McGraw-Hill Book Co, 2003.
3. P.C. Gope, “Machine Design – Fundamental and Application”, PHI learning private ltd, New Delhi, 2012.
4. R.B. Patel, “Design of Machine Elements”, MacMillan Publishers India P Ltd., Tech-Max Educational resources, 2011.
5. Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine Design”, 4th Edition, Wiley, 2005
6. Sundararajamoorthy T. V. Shanmugam .N, “Machine Design”, Anuradha Publications, Chennai, 2015.

7.Robert L.Norton, “Machine Design An Integrated Approach”, fifth edition Pearson Education India, 2013.

ME1504	HEAT AND MASS TRANSFER	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT I CONDUCTION 9

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

UNIT II CONVECTION 9

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

UNIT III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS 9

Nusselt’s theory of condensation – Regimes of Pool boiling and Flow boiling. Correlations in boiling and condensation. Heat Exchanger Types – Overall Heat Transfer Coefficient – Fouling Factors – Analysis – LMTD method – NTU method.

UNIT IV RADIATION 9

Black Body Radiation – Grey body radiation – Shape Factor – Electrical Analogy – Radiation Shields. Radiation through gases.

UNIT V MASS TRANSFER 9

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 PERIODS

OUTCOMES:

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

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

TEXT BOOKS:

1. R.C. Sachdeva, “Fundamentals of Engineering Heat & Mass transfer”, New Age International Publishers, 2009.
2. Yunus A. Cengel, “Heat Transfer A Practical Approach”, Tata McGraw Hill, 5th Edition 2015

REFERENCES:

1. Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 1998.
2. Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 1998.
3. Nag, P.K., "Heat Transfer", Tata McGraw Hill, New Delhi, 2002
4. Ozisik, M.N., "Heat Transfer", McGraw Hill Book Co., 1994.
5. Holman, J.P., “Heat and Mass Transfer”, Tata McGraw Hill, 2000

ME 1505	METROLOGY & INSPECTION LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVE:

- To become familiar with different measurement equipment and use this for Quality inspection.

LIST OF EXPERIMENTS

1. Calibration and use of measuring instruments – Vernier caliper, micrometer, Vernier height gauge – using gauge blocks
2. Calibration and use of measuring instruments – bore gauge, telescopic gauge
3. Measurement of angles using bevel protractor and sine bar
4. Inspect, whether the dimensions of the given specimens are within the tolerance limit or not, using Comparators
5. Measurement of screw thread parameters using Floating carriage micrometer
6. Measurement of gear tooth thickness using gear tooth vernier caliper
7. Measurement of features in a prismatic component using Coordinate Measuring Machine (CMM)
8. Measurement of thread parameters by Tool Maker‘s Microscope
9. Measurement of Surface Roughness using portable surface roughness tester
10. Straightness /Flatness Testing using Autocollimator
11. Measurement of force, torque and temperature

TOTAL: 60 PERIODS

OUTCOMES:

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

- Select a suitable measuring instrument for measurement of linear and angular dimensions and use the same for carrying out measurements.
- Calibrate simple linear measuring instruments like Vernier caliper, micrometer, Vernier height gauge, etc. using gauge blocks.
- Use advanced measuring equipment like coordinate measuring machines, Toolmakers microscope, and surface finish measuring equipment to carryout measurements.
- Measure the gear tooth dimensions, straightness. Flatness and thread parameters.
- Measure temperature, force, displacement, torque.
- Handle Measuring Equipment with latest technologies.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

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

15	Coordinate measuring machine	1
16	Surface finish measuring equipment	1
17	Bore gauge	1
18	Telescope gauge	1

ME 1506 **HEAT TRANSFER LAB** **L T P C**
0 0 4 2

OBJECTIVES:

- To study the Performance of steam generator/ turbine
- To study the heat transfer phenomena predict the relevant coefficient using implementation
- To study the performance of refrigeration cycle / components

LIST OF EXPERIMENTS	
1.	Performance and Energy Balance Test on a Steam Generator.
2.	Performance and Energy Balance Test on Steam Turbine.
3.	Thermal conductivity measurement using guarded plate apparatus.
4.	Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
5.	Determination of heat transfer coefficient under natural convection from a vertical cylinder.
6.	Determination of heat transfer coefficient under forced convection from a tube.
7.	Determination of Thermal conductivity of composite wall.
8.	Determination of Thermal conductivity of insulating powder.
9.	Heat transfer from pin-fin apparatus (natural & forced convection modes)
10.	Determination of Stefan – Boltzmann constant.
11.	Determination of emissivity of a grey surface.
12.	Effectiveness of Parallel / counter flow heat exchanger.
13.	Performance test on a reciprocating air compressor
14.	Performance test in a HC Refrigeration System

TOTAL: 60 PERIODS

OUTCOMES:

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

- Conduct tests on heat conduction apparatus and evaluate thermal conductivity of materials.
- Conduct tests on natural and forced convective heat transfer apparatus and evaluate heat transfer coefficient.
- Conduct tests on radiative heat transfer apparatus and evaluate Stefan Boltzmann constant and emissivity.
- Conduct tests to evaluate the performance of parallel/counter flow heat exchanger apparatus and reciprocating air compressor.
- Conduct tests to evaluate the performance of refrigeration and air conditioning test rigs.
- Conduct tests to evaluate Convective and Radiative heat transfer.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Steam Boiler with turbine setup	1 No.
2	Guarded plate apparatus	1 No.
3	Lagged pipe apparatus	1 No.
4	Natural convection-vertical cylinder apparatus	1 No.
5	Forced convection inside tube apparatus	1 No.
6	Composite wall apparatus	1 No.
7	Thermal conductivity of insulating powder apparatus	1 No.
8	Pin-fin apparatus	1 No.
9	Stefan-Boltzmann apparatus	1 No.
10	Emissivity measurement apparatus	1 No.
11	Parallel/counter flow heat exchanger apparatus	1 No.
12	Single/two stage reciprocating air compressor	1 No.
13	Refrigeration test rig	1 No.
14	Fluidized bed cooling tower apparatus	1 No.

ME1601 **DESIGN OF MECHANICAL TRANSMISSION SYSTEMS** **L T P C**

3 0 0 3

OBJECTIVES:

- To gain knowledge on the principles and procedure for the design of Mechanical power Transmission components.
- To understand the standard procedure available for Design of Transmission of Mechanical elements
- To learn to use standard data and catalogues
  (Use of P S G Design Data Book permitted)

UNIT I DESIGN OF BELT, ROPES AND CHAIN **9**

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

UNIT II DESIGN OF SPUR AND HELICAL GEARS **9**

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

UNIT III 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. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

UNIT IV DESIGN OF GEAR BOXES **9**

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

UNIT V DESIGN OF CLUTCHES AND BRAKES **9**

Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches-Electromagnetic clutches. Band and Block brakes - external shoe brakes –Internal expanding shoe brake.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Apply the concepts of design to belts, chains and rope drives.
- Apply the concepts of design to spur, helical gears.
- Apply the concepts of design to worm and bevel gears.
- Apply the concepts of design to gear boxes.
- Apply the concepts of design to brakes and clutches.
- Design the power transmission elements for industrial applications.

TEXT BOOKS:

1. Bhandari V, "Design of Machine Elements",4th Edition, Tata McGraw-Hill Book Co, 2016.
2. Richard Budynas and Keith Nisbett " Shigley's Mechanical Engineering Design", 10th Edition, Tata McGraw-Hill, 2014.

REFERENCES:

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

ME1602	FINITE ELEMENT ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT I INTRODUCTION **9**

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems–Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT II ONE DIMENSIONAL ANALYSIS **9**

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors-Assembly of Matrices - Solution of problems from solid mechanics. Fourth Order Beam Equation- Problems on it.

UNIT III APPLICATION OF ONE-DIMENSIONAL ELEMENT TO HEAT TRANSFER AND VIBRATION **9**

Derivation of matrices and vector for heat transfer. Problems on Heat transfer. Natural frequencies of longitudinal vibration and mode shapes. Transverse Natural frequencies of beams.

UNIT IV TWO-DIMENSIONAL ANALYSIS **9**

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements and Quadrilateral elements- Shape functions and element matrices and vectors. Application to Field Problems. Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Constitutive matrices and Strain displacement matrices – Stiffness matrix – Stress calculations.

UNIT V ISOPARAMETRIC FORMULATION AND NUMERICAL INTEGRATION **9**

Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements – One and two dimensions – Serendipity elements – Numerical integration - Introduction to non-linearity.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Develop mathematical models for Boundary Value Problems and their numerical solution
- Apply the concepts of Finite Element Analysis to solve one dimensional problem in structural analysis

- Apply the concepts of Finite Element Analysis to solve one dimensional problem in Heat transfer and Dynamics
- Apply the concepts of Finite Element Analysis to solve two dimensional problems in structural analysis
- Apply the Isoparametric transformation and the use of numerical integration for various analysis
- Apply FEA concepts in all Engineering Applications.

TEXT BOOKS:

1. Rao S. S, "The Finite Element Method in Engineering", 6th Edition, ButterworthHeinemann,2018.
2. Tirupathi R. Chandrupatla and Ashok D. Belegundu, "Introduction to Finite Elements in Engineering", International Edition, Pearson Education Limited, 2014.

REFERENCES:

1. David Hutton, "Fundamentals of Finite Element Analysis", Tata McGrawHill, 2017.
2. Reddy, J.N. "Introduction to the Finite Element Method", 4thEdition, Tata McGrawHill,2018.
3. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, "Concepts and Applications of Finite Element Analysis", 4th Edition, Wiley Student Edition, 2007.
4. Seshu. P, "Text Book of Finite Element Analysis", PHI Learning Pvt. Ltd., NewDelhi, 2013.
5. Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons, 2005 (Indian Reprint 2013).

ME1603	MECHATRONICS	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To impart knowledge about the elements and techniques involved in Mechatronics systems which are very much essential to understand the emerging field of automation.

UNIT I INTRODUCTION 9

Introduction to Mechatronics – Systems – Concepts of Mechatronics approach – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance sensors – Strain gauges – Eddy current sensor – Hall effect sensor – Temperature sensors – Light sensors

UNIT II MICROPROCESSOR AND MICROCONTROLLER 9

Introduction – Architecture of 8085 – Pin Configuration – Addressing Modes –Instruction set, Timing diagram of 8085 – Concepts of 8051 microcontroller – Block diagram

UNIT III PROGRAMMABLE PERIPHERAL INTERFACE 9

Introduction – Architecture of 8255, Keyboard interfacing, LED display –interfacing, ADC and DAC interface, and Temperature Control – Stepper Motor Control – Traffic Control interface.

UNIT IV PROGRAMMABLE LOGIC CONTROLLER 9

Introduction – Basic structure – Input and output processing – Programming – Mnemonics – Timers, counters and internal relays – Data handling – Selection of PLC.

UNIT V ACTUATORS AND MECHATRONIC SYSTEM DESIGN 9

Types of Stepper and Servo motors – Construction – Working Principle – Advantages and Disadvantages. Design process-stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Engine Management system – Automatic car park barrier.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Understand the interdisciplinary applications of Electronics, Electrical, Mechanical and Computer Systems for the Control of Mechanical, Electronic Systems and sensor technology.
- Understand the architecture of Microprocessor and Microcontroller.
- Discuss Programmable Peripheral Interface, Architecture of 8255 PPI, and various device interfacing.
- Explain the architecture, programming and application of programmable logic controllers to problems and challenges in the areas of Mechatronic engineering.
- Discuss various Actuators for mechatronics applications.

- Design various Mechatronics system using the knowledge and skills acquired through the course.

TEXT BOOKS:

1. Bolton, "Mechatronics", Prentice Hall, 2008
2. Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", 5th Edition, Prentice Hall, 2008.

REFERENCES:

1. Bradley D.A, Dawson D, Buru N.C and Loader A.J, Mechatronics, Chapman and Hall, 1993.
2. Clarence W, de Silva, "Mechatronics" CRC Press, First Indian Re-print, 2013
3. Devadas Shetty and Richard A. Kolk, Mechatronics Systems Design, PWS publishing company, 2007.
4. Krishna Kant, Microprocessors and Microcontrollers, Prentice Hall of India, 2007.
5. Michael B.Histand and Davis G.Alciatore, Introduction to Mechatronics and Measurement systems, McGraw Hill International edition, 2007.

ME 1604	COMPUTER AIDED DESIGN AND MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT I INTRODUCTION 9

Product cycle- Design process- sequential and concurrent engineering- Computer aided design – CAD system architecture- Computer graphics – co-ordinate systems- 2D and 3D transformations - homogeneous coordinates – Line drawing -Clipping- viewing transformation-Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control. Automation in CAD/CAM & related Concepts.

UNIT II GEOMETRIC MODELING 9

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

UNIT III CAD STANDARDS 9

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

UNIT IV FUNDAMENTAL OF CNC AND PART PROGRAMING 9

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

UNIT V GROUP TECHNOLOGY AND FLEXIBLE MANUFACTURING SYSTEM (FMS) 9

Introduction, needs of GT, part families, classification and coding systems, Simple Problems in Opitz Part Coding system, GT machine cells, benefits of GT. Computer integrated manufacturing (CIM) system, Types of Flexibility, FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control.

TOTAL: 45 PERIODS

OUTCOMES:

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

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

TEXT BOOKS:

1. Ibrahim Zeid "Mastering CAD CAM" Tata McGraw-Hill PublishingCo.2007
2. Radhakrishnan P, Subramanyan S. and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi,2000

REFERENCES:

1. Chris McMahon and Jimmie Browne "CAD/CAM Principles", "Practice and Manufacturing management "Second Edition, Pearson Education, 1999.
2. William M Neumann and Robert F.Sproul "Principles of Computer Graphics", McGraw Hill Book Co. Singapore, 1989.
3. Donald Hearn and M. Pauline Baker "Computer Graphics"'. Prentice Hall, Inc,1992.
4. Foley, Wan Dam, Feiner and Hughes - "Computer graphics principles & practice" Pearson Education -2003
5. Mikell.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2008.

ME 1613	I.C. ENGINES LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To study the valve timing, p-V diagram and performance of IC Engines
- To Study the characteristics of fuels/Lubricates used in IC Engines

LIST OF EXPERIMENTS

1. Valve Timing diagram of four stroke engine.
2. Port Timing diagram of two stroke engine.
3. Actual p-v diagrams of IC engines.
4. Performance Test on 4 – stroke Diesel Engine.
5. Heat Balance Test on 4 – stroke Diesel Engine.
6. Morse Test on Multi-cylinder Petrol Engine.
7. Retardation Test on a Diesel Engine.
8. Determination of Flash Point and Fire Point of various fuels / lubricants
9. Determination of viscosity in Redwood Viscometer

TOTAL: 60 PERIODS

OUTCOMES:

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

- Demonstrate the principles of Internal Combustion engines.
- Study the characteristic curves on IC engines.
- Conduct performance experiment on IC engines.
- Study & Draw the heat balance sheets for the IC engines.
- Conduct Morse Test experiment on IC engines.
- Study about friction power effects on IC engines in Retardation Test.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	I.C Engine – 2 stroke and 4 stroke model	1 SET
2	Apparatus for Flash and Fire Point	1 No.
3	Redwood Viscometer apparatus	1 No.
4	4-stroke Diesel Engine with mechanical/electrical loading.	1 No.
5	4-stroke Diesel Engine with hydraulic loading.	1 No.
6	Multi-cylinder Petrol Engine	1 No.
7	Data Acquisition system with any one of the above engines	1 No.

ME1614	INNOVATIVE PROJECT	L	T	P	C
		0	0	4	2

OBJECTIVE:

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

GUIDELINE FOR REVIEW AND EVALUATION

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

TOTAL: 60 PERIODS

OUTCOMES:

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

- Design the machine element or the mechanical product.
- Fabricate the machine element or the mechanical product.
- Develop the solutions for specific real time problems.
- Apply the principles of engineering and codes of practice while developing solutions.
- Able to develop team work.
- Demonstrate the working model of the machine element or the mechanical product.

ME1605	DESIGN OF JIGS, FIXTURES AND PRESS TOOL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the functions and design principles of Jigs, fixtures and press tools
- To gain proficiency in the development of required views of the final design

UNIT I LOCATING AND CLAMPING PRINCIPLES: 9

Objectives of tool design- Function and advantages of Jigs and fixtures – Basic elements – principles of location – Locating methods and devices – Redundant Location – Principles of clamping – Mechanical actuation – pneumatic and hydraulic actuation Standard parts – Drill bushes and Jig buttons – Tolerances and materials used.

UNIT II JIGS AND FIXTURES 9

Design and development of jigs and fixtures for given component- Types of Jigs – Post, Turnover, Channel, latch, box, pot, angular post jigs – Indexing jigs – General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fixturing systems- Quick change fixtures.

UNIT III PRESS WORKING TERMINOLOGIES AND ELEMENTS OF CUTTING DIES 9

Press Working Terminologies - operations – Types of presses – press accessories – Computation of press capacity – Strip layout – Material Utilization – Shearing action – Clearances – Press Work Materials – Centre of pressure- Design of various elements of dies – Die Block – Punch holder, Die set, guide plates – Stops – Strippers – Pilots – Selection of Standard parts – Design and preparation of four standard views of simple blanking, piercing, compound and progressive dies.

UNIT IV BENDING AND DRAWING DIES 9

Difference between bending and drawing – Blank development for above operations – Types of Bending dies – Press capacity – Spring back – knockouts – direct and indirect – pressure pads – Ejectors – Variables affecting Metal flow in drawing operations – draw die inserts – draw beads- ironing – Design and development of bending, forming, drawing, reverse redrawing and combination dies – Blank development for axisymmetric, rectangular and elliptic parts – Single and double action dies.

UNIT V FORMING TECHNIQUES AND EVALUATION 9

Bulging, Swaging, Embossing, coining, curling, hole flanging, shaving and sizing, assembly, fine Blanking dies – recent trends

in tool design- computer Aids for sheet metal forming Analysis – basic introduction - tooling for numerically controlled machines- setup reduction for work holding – Single minute exchange of dies – Poka Yoke.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Summarize the different methods of Locating Jigs and Fixtures and Clamping principles
- Design and develop jigs and fixtures for given component
- Discuss the press working terminologies and elements of cutting dies
- Distinguish between Bending and Drawing dies.
- Discuss the different types of forming techniques
- Design jigs, fixtures and press tool for different components and come up with the cost of making the tool.

TEXT BOOKS:

1. Joshi, P.H. "Jigs and Fixtures", Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2010.
2. Joshi P.H "Press tools - Design and Construction", wheels publishing, 1996

REFERENCES:

1. ASTME Fundamentals of Tool Design Prentice Hall of India.
2. Design Data Hand Book, PSG College of Technology, Coimbatore.
3. Donaldson, Lecain and Goold "Tool Design", 5th Edition, Tata McGraw Hill, 2017.
4. Hoffman "Jigs and Fixture Design", Thomson Delmar Learning, Singapore, 2004.
5. Kempster, "Jigs and Fixture Design", Third Edition, Hoddes and Stoughton, 1974.
6. Venkataraman. K., "Design of Jigs Fixtures & Press Tools", Tata McGraw Hill, New Delhi, 2005.

ME1606	**DESIGN FOR MANUFACTURE AND ASSEMBLY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

To know the concept of design for manufacturing and assembly

To know the computer application in design for manufacturing and assembly.

UNIT I INTRODUCTION 5

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric tolerances - Assembly limits -Datum features - Tolerance stacks.

UNIT II FACTORS INFLUENCING FORM DESIGN 13

Working principle, Material, Manufacture, Design- Possible solutions - Materials choice – Influence of materials on form design - form design of welded members, forgings and castings.

UNIT III COMPONENT DESIGN - MACHINING CONSIDERATION 8

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability – Design for accessibility - Design for assembly – Product design for manual assembly - Product design for automatic assembly – Robotic assembly.

UNIT IV COMPONENT DESIGN – CASTING CONSIDERATION 10

Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA

UNIT V COMPONENT DESIGN – WELDING CONSIDERATION 9

Appraisal of various welding processes, factors in design of weldments, general design guidelines, pre and post treatment of welds, effects of thermal stresses in weld joints.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Understand the design principles for manufacturability
- Understand the factors influencing form design
- Apply the machining considerations when design the components for machinability
- Apply the casting considerations when design the components for casatability
- Apply the welding considerations when design the components for weldability
- Apply the design principles with manufacturing and assembly considerations.

TEXT BOOKS:

1. Harry Peck , Designing for manufacture, Pitman– 1973

REFERENCES:

1. Boothroyd, G, 1980 Design for Assembly Automation and Product Design. New York, Marcel Dekker.
2. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994.
3. Bralla, Design for Manufacture handbook, McGraw hill, 1999.
4. Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995.
5. Fixel, J. Design for the Environment McGraw Hill., 1996.
6. Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.
7. Kevin Otto and Kristin Wood, Product Design. Pearson Publication, (Fourth Impression) 2009.

ME1607	MATERIAL CHARACTERIZATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To expose the students with thermal, microscopic, electrical and spectroscopic methods of characterization.
- To study and understand the various Non-Destructive Evaluation and Testing methods, theory and their industrial applications.

UNIT I OPTICAL METALLOGRAPHIC TECHNIQUES 9

Importance of material characterization –classification of material characterization techniques –mechanical characterization process –measurement of hardness –fracture toughness through nano indentation –adhesion test-surface profilometry – tribological studies of materials, Optical microscopic techniques. Macro examination-applications –metallurgical microscope – principle, construction and working, metallographic specimen preparation.

UNIT II SURFACE ANALYSIS TECHNIQUES 9

Importance of surface characterization techniques–principle, working and applications of AFM, Surface area, pore volume measurements by B.E.T. method, Mercury porosimetry -Particle size measurement, Principle and working of SEM, STEM, TEM, imaging dark and bright field–specimen preparation techniques–merits and demerits-applications

UNIT III X RAY DIFFRACTION & ION BEAM TECHNIQUES 9

Characteristic X–ray spectrum-Bragg's Law–Diffraction methods-Laue method, rotating crystal method, powder method –X ray diffractometer–determination of crystal structure–lattice parameter-measurement of residual stress. Rutherford Backscattering Spectrometry (RBS), Secondary Ion Mass Spectroscopy, Electron backscatter diffraction (EBSD), Focused Ion Beam (FIB), elastic recoil detection analysis and nuclear reaction analysis

UNIT IV OVERVIEW OF NDT 9

NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT, Visual inspection – Unaided and aided.

UNIT V SURFACE NDE METHODS 9

Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection

materials Magnetization methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

TOTAL: 45 PERIODS

OUTCOMES:

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

- categorize the various types of material characterization techniques
- illustrate the several types of surface characterization techniques
- visualize the importance of X-ray diffraction and Ion beam techniques
- elaborate the different methods of non-destructive testing
- summarize the various methods available for non-destructive evaluation
- describe the practical applications of several surface analysis techniques

TEXT BOOKS:

1. A. Mammoli, C. A. Brebbia and A. Klemm, Materials Characterization, WIT Press, 1stedition, (2011).
2. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2009.

REFERENCES:

1. B. D. Cullity, Elements of X-ray Diffraction, Prentice Hall, 3rd edition, (2001).
2. V. A. Phillips, Modern Metallographic Techniques and their Applications, John Wiley & Sons, 1stedition, (1972).
3. V. T. Cherepin and A. K. Mallic, Experimental Techniques in Physical Metallurgy, Asia Publishing Company, (1967)
4. V. Voort, Metallography: Principle and practice, ASM International, (1999).
5. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition New Jersey, 2005
6. Charles, J. Hellier, Handbook of Non-destructive evaluation", McGraw Hill, New York 2001.
7. K. R. Hebbar, Basics of X-Ray Diffraction and its Applications, I.K. International Publishing House Pvt Ltd, (2007)
8. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010

ME1608	RENEWABLE ENERGY SOURCES	L	T	P	C
		3	0	0	3

OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Describing the current energy scenario in terms of conventional renewable energy and future plan.
- Applying the principle of various solar energy generating devices.
- Applying the principle of various wind energy devices.
- Applying the principle of various bio energy devices.
- Applying the principle of various ocean and geothermal energy devices

UNIT I ENERGY SCENARIO 9

Indian energy scenario in various sectors - domestic, industrial, commercial, agriculture, transportation and others - Present conventional energy status - Present renewable energy status - Potential of various renewable energy sources - Global energy status-Per capita energy consumption in various countries - Future energy plans.

UNIT II SOLAR ENERGY 9

Solar radiation – Measurements of solar radiation and sunshine – Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications

UNIT III WIND ENERGY 9

Wind data and energy estimation – Betz limit - Site selection for wind farms – characteristics Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.

UNIT IV BIO-ENERGY 9

Bio resources - Biomass direct combustion - thermochemical conversion - biochemical conversion - mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration - Carbonisation - Pyrolysis - Biogas plants – Digesters - Biodiesel production - Ethanol production - Applications.

UNIT V OCEAN AND GEOTHERMAL ENERGY 9

Small hydro - Tidal energy - Wave energy - Open and closed OTEC Cycles – Limitations - Geothermal energy - Geothermal energy sources - Types of geothermal power plants - Applications - Environmental impact.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Describe the current energy scenario in terms of conventional renewable energy and future plan.
- Apply the principle of various solar energy generating devices.
- Apply the principle of various wind energy devices.
- Apply the principle of various bio energy devices.
- Apply the principle of various ocean and geothermal energy devices.
- Understand techniques in direct energy conversion.

TEXT BOOKS:

1. G.D. Rai, "Non-Conventional Energy Sources", Standard Publishers Distributors, 1992.
2. John Twidell, Tony Weir, and Anthony D. Weir, Renewable Energy Resources, Taylor & Francis, 2006.

REFERENCES:

1. B.H. Khan, "Non-Conventional Energy Resources", McGraw Hill, 2009.
2. G.N. Tiwari, "Solar Energy – Fundamentals Design, Modelling and applications", Alpha Science, 2015.
3. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, 2012.
4. N.K. Bansal, Non-Conventional Energy Resources, Vikas Publishing House, 2014.
5. S.P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", Tata McGraw Hill, 2009.

ME1609	GAS DYNAMICS AND JET PROPULSION	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT I FUNDAMENTALS OF COMPRESSIBLE FLOW 9

Basics of Thermodynamics & Fluid Mechanics, Energy and momentum equations of compressible fluid flows – Stagnation states, Mach waves and Mach cone – Effect of Mach number on compressibility.

UNIT II ISENTROPIC FLOWS (VARIABLE AREA DUCT) 9

Isentropic flow through variable area ducts, T-s and h-s diagrams for nozzle and diffuser flows, area ratio as a function of Mach number, mass flow rate through nozzles and diffusers, effect of friction in flow through nozzles.

UNIT III FLOW THROUGH CONSTANT AREA DUCT 9

One-dimensional flow with heat addition (Rayleigh flow) - analysis and working equations for perfect gas - thermal chocking - reference state and Rayleigh table. One-dimensional flow with friction (Fanno flow) - analysis and working relations for perfect gas - limiting point - friction chocking - reference state and Fanno table.

UNIT IV NORMAL AND OBLIQUE SHOCKS 9

Governing equations – Normal and oblique shocks, causes and effects of shocks, Prandtl-Meyer and Rankin-Hugoniot equation equations – Applications.

UNIT V PROPULSION SYSTEMS 9

Fundamentals of jet & Rocket propulsion – Thrust power and propulsive efficiency – principle, propulsion cycle, power and efficiency calculations of Ram jet, Turbojet, Turbofan and Turbo Prop engines. Rocket engines – Propellants - Feeding systems – Ignition and combustion – Theory of rocket propulsion – Performance – Staging – Terminal and characteristic velocity –

Applications - space flights

TOTAL: 45 PERIODS

OUTCOMES:

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

- Derive and apply equations for one-dimensional compressible flow from integral forms of the governing equations
- Determine geometric design parameters required to accelerate or decelerate an isentropic flow for a given type of nozzle or diffuser, operating under specified conditions
- Estimate the length of a one-dimensional constant area duct to achieve desired changes in properties via the effects of friction and heat transfer
- Evaluate changes in physical properties when a normal shock & oblique shock occurs
- Understand different components of aircraft propulsion systems using principles of thermodynamics
- Analyze different aircraft propulsion systems.

TEXT BOOKS:

1. John D. Anderson, Jr., "Modern Compressible Flow with Historical Perspective", McGraw- Hill, 3rd Edition 2004.
2. Yahya S. M., "Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion", New Age International (P) Ltd., 3rd Edition, 2003.

REFERENCES:

1. Robert D. Zucker, Oscar Biblarz, "Fundamentals of Gas Dynamics", Wiley India Pvt. Ltd., 2nd Edition, 2011.
2. Radhakrishnan E., "Gas Dynamics", Prentice Hall of India, New Delhi, 2006.
3. Saravanamuttoo, GFC Rogers, and Cohen. H, "Gas Turbine Theory", Pearson Education, 5th Edition, 2003.
4. Philip Hill, Carl Peterson, "Mechanics and Thermodynamics of Propulsion", Pearson Education, 2nd Edition, 2011.
5. Babu V., "Fundamentals of Gas Dynamics", John Wiley & Sons, 2015. 6. Oosthuizen P. H. and Carscallen W.E., "Compressible Fluid Flow", McGraw Hill, 1997.
6. Ganesan V., "Gas Turbine", Tata McGraw-Hill, New Delhi, 2005.

ME1610	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To learn the basics of deterministic optimization tools.

UNIT I LINEAR PROGRAMMING 9

Introduction - Formulation of linear programming model - Graphical solution – Solving LPP using simplex algorithm – Revised Simplex Method.

UNIT II ADVANCES IN LPP – I 9

Duality theory - Dual simplex method - Sensitivity analysis – Transportation problems – Assignment problems - Traveling sales man problem

UNIT III ADVANCES IN LPP – II 9

Integer programming – Multi objective optimization: Goal programming–Introduction to Data Envelopment Analysis

UNIT IV NETWORK MODELS 9

Maximal flow problems – Shortest route problem – Minimal spanning tree - Project network -CPM – PERT – Crashing.

UNIT V DYNAMIC PROGRAMMING 9

Elements of dynamic programming – state –stage-recursive equations – computational procedure – applications

TOTAL: 45 PERIODS

OUTCOMES:

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

- Formulate and solve linear programming problems.
- Solve duality, transportation and assignment.

- Understand about multi objective optimization techniques
- Understand and formulate various network models
- Understand about the basics of dynamic programming
- Formulate and optimize various problems.

TEXT BOOKS:

1. G.Srinivasan., "Operations Research Principles and Applications", PHI, 2008.
2. R.Panneerselvam, "Operations Research", PHI, 2006

REFERENCES:

1. Philips, Ravindran and Solberg, "Operations Research", John Wiley,2002
2. Hamdy A Taha, "Operations Research – An Introduction", Prentice Hall India, 2003.
3. Ronald L Rardin, "Optimisation in Operations Research", Pearson, 2003.
4. David R. Anderson, et al, "An Introduction to Management Science" – Quantitative approaches to Decision Making, Thomson, 2003.
5. Hillier and Lieberman, "Introduction to Operations Research", TMH, 2000.

ME1611	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
- Explain the TQM Principles for application.
- Define the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
- Describe Taguchi's Quality Loss Function, Performance Measures and apply Techniques like QFD, TPM, COQ and BPR.
- Illustrate and apply QMS and EMS in any organization.

UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality – Definition of TQM-- Basic concepts of TQM –-Gurus of TQM (Brief introduction) -- TQM Framework- Barriers to TQM – Benefits of TQM.

UNIT II TQM PRINCIPLES 9

Leadership - Deming Philosophy, Quality Council, Quality statements and Strategic planning- Customer Satisfaction – Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal--Continuous process improvement –Juran Trilogy, PDSA cycle, 5S and Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating and Relationship development.

UNIT III TQM TOOLS & TECHNIQUES I 9

The seven traditional tools of quality - New management tools - Six-sigma Process Capability- Bench marking - Reasons to benchmark, Benchmarking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, Learning from the data, Using the findings, Pitfalls and Criticisms of Benchmarking - FMEA - Intent , Documentation, Stages: Design FMEA and Process FMEA.

UNIT IV TQM TOOLS & TECHNIQUES II 9

Quality circles – Quality Function Deployment (QFD) - Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures- Cost of Quality - BPR.

UNIT V QUALITY MANAGEMENT SYSTEM 9

Introduction-Benefits of ISO Registration-ISO 9000 Series of Standards-Sector-Specific Standards - AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements-Implementation-Documentation-Internal Audits-Registration-ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001-Benefits of EMS.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Ability to apply TQM concepts in a selected enterprise.
- Ability to apply TQM principles in a selected enterprise.
- Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
- Ability to understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.
- Ability to apply QMS and EMS in any organization.
- Summarize the basic concepts in total quality management relevant to manufacturing and service sectors.

TEXT BOOKS:

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Bester field, MaryB.Sacre, Hemant Urdhwareshe and RashmiUrdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.

REFERENCES:

1. Joel.E. Ross, "Total Quality Management – Text and Cases",Routledge.,2017.
2. Kiran.D.R, "Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.
3. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.
4. Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006 .

ME1612	ENTREPRENEURSHIP AND DEVELOPMENT OF INDUSTRIES	L	T	P	C
		3	0	0	3

OBJECTIVE:

Study of this subject provides an understanding of the scope of an entrepreneur, key areas of development, financial assistance by the institutions, methods of taxation and tax benefits, etc.

UNIT I ENTREPRENEURSHIP 9

Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.

UNIT II MOTIVATION 9

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self Rating, Business Game, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.

UNIT III BUSINESS 9

Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – Identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment– Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.

UNIT IV FINANCING AND ACCOUNTING 9

Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, Management of working Capital, Costing, Break Even Analysis, Network Analysis Techniques of PERT / CPM – Taxation – Income Tax, Excise Duty – Sales Tax.

UNIT V SUPPORT TO ENTREPRENEURS 9

Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of the course, students will be able to

- Understand the concept of entrepreneurship
- Understand self-rating processes and development methods
- Understand good practices involved in business, survey and market analysis
- Understand fundamentals of financing and accounting

- Understand consequences and government policies.
- Gain knowledge and skills needed to run a business successfully.

TEXT BOOKS:

1. S.S.Khanka, "Entrepreneurial Development" S.Chand & Co. Ltd. Ram Nagar New Delhi, 1999.

2. Kurahko & Hodgetts, " Enterprenuership – Theory, process and practices", Thomson learning 6th edition.

REFERENCES:

1. Hisrich R D and Peters M P, "Entrepreneurship" 5th Edition Tata McGraw-Hill, 2002.

2. Mathew J Manimala," Enterprenuership theory at cross roads: paradigms and praxis" Dream tech, 2nd edition 2006.

3. Rabindra N. Kanungo, "Entrepreneurship and innovation", Sage Publications, New Delhi, 1998.

4. EDII " Faulty and External Experts – A Hand Book for New Entrepreneurs Publishers: Entrepreneurship Development", Institute of India, Ahmadabad, 1986.

OME501	INTERNAL COMBUSTION ENGINES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge in various manufacturing methods in developing automotive components.
- To study the concepts of automobile engineering.
- To impart the knowledge in various parts of automotive engine.
- To understand the concepts of fuel and transmission system.
- To learn the recent developments in automobile industries.

UNIT I INTRODUCTION TO IC ENGINES 9

Engine classification, Air standard cycles, Otto, Diesel, Stirling, Ericsson cycles, Actual cycle analysis, Two and four stroke engines, SI and CI engines, Valve timing diagram, Rotary engines, stratified charge engine.

UNIT II FUELS 9

Fuels for SI and CI engine, important qualities of SI engine fuels, Rating of SI engine fuels, Important qualities of CI engine fuels, Dopes, Additives, Gaseous fuels, LPG, CNG, Biogas, Producer gas, Alternative fuels for IC engines

UNIT III SI ENGINES 9

Carburetion, Mixture requirements, Carburetor types, Theory of carburetor, MPFI, Combustion in SI engine, Flame speed, Ignition delay, abnormal combustion and its control, combustion chamber design for SI engines. Ignition system requirements; Magneto and battery ignition systems, ignition timing and spark plug, electronic ignition.

UNIT IV CI ENGINES 9

Fuel injection in CI engines, Requirements, Types of injection systems, Fuel pumps, Fuel injectors, Injection timing. Combustion in CI engines, Ignition delay, Knock and its control, Combustion chamber design of CI engines. Scavenging in 2 Stroke engines, pollution, and its control.

UNIT V ENGINE TESTING & PERFORMANCE 9

Supercharging - Effect of altitude on power output, types of supercharging. Testing and Performance, Performance parameters, Basic measurements, blow by measurement, Testing of SI and CI engines.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Understand basics and principles of engine operation.
- Gain knowledge on fuels used in IC engines.
- Understand the working principles and components of SI engines.
- Understand the working principles and components of CI engines.
- Learn methods to improve and test the performance of IC engines.
- Understand the concepts of automation and latest technologies in IC Engines.

TEXT BOOKS:

1. Ganesan, V, Internal Combustion Engines, Tata McGraw Hill Book Co., 2003.

REFERENCES:

1. B.P. Pundir Engine Combustion and Emission, Narosa Publishing House, 2011.
2. Domkundwar V, A Course in Internal Combustion Engines, Dhanpat Rai & Co. (P) Ltd, 2002.
3. John B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill Book, 1998.
4. Mathur, M.L., and Sharma, R.P., A Course in Internal Combustion Engines, Dhanpat Rai Publications Pvt.New Delhi-2, 1993.
5. Rajput R.K. Internal Combustion Engines, Laxmi Publications (P) Ltd, 2006.

OME502	INTRODUCTION TO NANO TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVE:

- Make the students to understand about the nanomaterials, synthesis and its characterization

UNIT I BASICS AND SCALE OF NANOTECHNOLOGY 9

Introduction –Scientific revolutions –Time and length scale in structures –Definition of a nanosystem –Dimensionality and size dependent phenomena –Surface to volume ratio -Fraction of surface atoms –Surface energy and surface stress- surface defects- Properties at nanoscale (optical, mechanical, electronic and magnetic).

UNIT II DIFFERENT CLASSES OF NANOMATERIALS 9

Classification based on dimensionality-Quantum Dots, Wells and Wires- Carbon- based nano materials (buckyballs, nanotubes, graphene)–Metal based nano materials (nanogold, nano silver and metal oxides) -Nanocomposites- Nano polymers –Nano glasses –Nano ceramics -Biological nanomaterials

UNIT III SYNTHESIS OF NANOMATERIALS 9

Classification of synthesis: Top-down and bottom-up nanofabrication. Chemical Methods: Metal Nanocrystals by Reduction - Solvothermal Synthesis- Photochemical Synthesis – Sono chemical Routes- Chemical Vapor Deposition (CVD) –Metal Oxide - Chemical Vapor Deposition (MOCVD), Physical Methods: Ball Milling –Electrodeposition - Spray Pyrolysis - Flame Pyrolysis - DC/RF Magnetron Sputtering - Molecular Beam Epitaxy (MBE).

UNIT IV FABRICATION AND CHARACTERIZATION OF NANOSTRUCTURES 9

Nanofabrication: Photolithography and its limitation-Electron-beam lithography (EBL)- Nanoimprint –Soft lithography patterning. Characterization: Field Emission Scanning Electron Microscopy (FESEM) –Environmental Scanning Electron Microscopy (ESEM) High Resolution Transmission Electron Microscope (HRTEM) –Scanning Tunneling Microscope (STM)- Surface enhanced Raman spectroscopy (SERS)- X-ray Photoelectron Spectroscopy (XPS) - Auger electron spectroscopy (AES) –Rutherford backscattering spectroscopy (RBS).

UNIT V APPLICATIONS 9

Solar energy conversion and catalysis, Molecular electronics and Nanoelectronics, Polymers with a special architecture, Liquid crystalline systems, Linear and nonlinear optical and electrooptical properties, Applications in displays and other devices, Advanced organic materials for data storage, Photonics, Plasmonics, Chemical and biosensors, Nanomedicine and Nanobiotechnology- –Nanotoxicology challenges.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Familiarize with the fundamentals of Nano technology.
- Understand the different classes of nanomaterials.
- Understand the synthesis of nanomaterials.
- Know about the fabrication and characterization of nanostructures.
- Apply nano technology in various fields.
- Know about the extraction of Nano structures and Nano Materials.

TEXT BOOKS:

1. Bhusan, Bharat (Ed), “Springer Handbook of Nanotechnology”, 2nd Edition, 2007.

2. Pradeep T., “A Textbook of Nanoscience and Nanotechnology”, Tata McGraw Hill Education Pvt. Ltd., 2012.

REFERENCES:

1. Charles P. Poole Jr., Frank J. Ownes, ‘Introduction to Nanotechnology”, Wiley Interscience, 2003.
2. Dupas C., Houdy P., Lahmani M., “Nanoscience: Nanotechnologies and Nanophysics”, Springer-Verlag Berlin Heidelberg, 2007.
3. Mark Ratner and Daniel Ratner, “Nano Technology”, Pearson Education, New Delhi, 2003.
4. Nabok A., “Organic and Inorganic Nanostructures”, Artech House, 2005
5. Thomas Varghese and K.M. Balakrishna “Nanotechnology: An Introduction to Synthesis, Properties and Applications of Nanomaterials”, Atlantic Publishers and Distributors (P) Ltd., 2011.
6. Hari Singh Nalwa, “Nanostructured Materials and Nanotechnology”, Academic Press, 2002.

OME503	PRODUCT DESIGN AND DEVELOPMENT	L	T	P	C
		3	0	0	3

OBJECTIVE:

- Providing the basic concepts of product design, product features and its architecture so that student can have a basic knowledge in the common features a product has and how to incorporate them suitably in product.

UNIT I INTRODUCTION 9

Need for IPPD – Strategic importance of Product development – integration of customer, designer, material supplier and process planner, Competitor and customer – Behaviour analysis. Understanding customer – prompting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specifications.

UNIT II CONCEPT GENERATION AND SELECTION 9

Task – Structured approaches – clarification – search – externally and internally – explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits

UNIT III PRODUCT ARCHITECTURE 9

Implications – Product change – variety – component standardization – product performance – manufacturability – product development management – establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications

UNIT IV INDUSTRIAL DESIGN 9

Integrate process design – Managing costs – Robust design – Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically – Need for industrial design – impact – design process – investigation of for industrial design – impact – design process – investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design

UNIT V DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT 9

Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs – Minimize system complexity – Prototype basics – principles of prototyping – planning for prototypes – Economic Analysis – Understanding and representing tasks – baseline project planning – accelerating the project – project execution.

TOTAL: 45 PERIODS

OUTCOMES:

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

- understand the concept of Integrated by product and process development.
- know procedure of product concept generation.
- know how to design, make, sell, use, and repair a new product.
- know how to produce mass production in new product
- understand the concept of how to manufacturing the better product at low cost.
- design some products for the given set of applications.

TEXT BOOKS:

1. Kari T.Ulrich and Steven D.Eppinger, "Product Design and Development", McGraw-Hill International Edns. 1999.

REFERENCES:

1. Kemnneth Crow, "Concurrent Engg./Integrated Product Development", DRM Associates, 26/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book.
2. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin, Homewood, 1992, ISBN 1-55623-603-4.
3. Staurt Pugh, "Tool Design –Integrated Methods for Successful Product Engineering", Addison Wesley Publishing, New york, NY.

OME504	LEAN SIX SIGMA	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To gain insights about the importance of lean manufacturing and six sigma practices.

UNIT I LEAN & SIX SIGMA BACKGROUND AND FUNDAMENTALS 9

Historical Overview – Definition of quality – What is six sigma -TQM and Six sigma - lean manufacturing and six sigma- six sigma and process tolerance – Six sigma and cultural changes – six sigma capability – six sigma need assessments - implications of quality levels, Cost of Poor Quality (COPQ), Cost of Doing Nothing – assessment questions

UNIT II THE SCOPE OF TOOLS AND TECHNIQUES 9

Tools for definition – IPO diagram, SIPOC diagram, Flow diagram, CTQ Tree, Project Charter – Tools for measurement – Check sheets, Histograms, Run Charts, Scatter Diagrams, Cause and effect diagram, Pareto charts, Control charts, Flow process charts, Process Capability Measurement, Tools for analysis – Process Mapping, Regression analysis, RU/CS analysis, SWOT, PESTLE, Five Whys, interrelationship diagram, overall equipment effectiveness, TRIZ innovative problem solving – Tools for improvement – Affinity diagram, Normal group technique, SMED, 5S, mistake proofing, Value stream Mapping, forced field analysis.

UNIT III SIX SIGMA METHODOLOGIES 9

Design For Six Sigma (DFSS),Design For Six Sigma Method - Failure Mode Effect Analysis (FMEA), FMEA process - Risk Priority Number (RPN)- Six Sigma and Leadership, committed leadership – Change Acceleration Process (CAP)- Developing communication plan – Stakeholder

UNIT IV SIX SIGMA IMPLEMENTATION AND CHALLENGES 9

Tools for implementation – Supplier Input Process Output Customer (SIPOC) – Quality Function Deployment or House of Quality (QFD) – alternative approach –implementation – leadership training, close communication system, project selection – project management and team – champion training – customer quality index – challenges – program failure, CPQ vs six sigma, structure the deployment of six sigma – cultural challenge – customer/internal metrics

UNIT V EVALUATION AND CONTINUOUS IMPROVEMENT METHODS 9

Evaluation strategy – the economics of six sigma quality, Return on six Sigma (ROSS), ROI, poor project estimates – continuous improvement – lean manufacturing – value, customer focus, Perfection, focus on waste, overproduction – waiting, inventory in process (IIP), processing waste, transportation, motion, making defective products, underutilizing people – Kaizen – 5S

TOTAL: 45 PERIODS

OUTCOMES:

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

- Understand the fundamentals of Lean and Six sigma.
- Understand the tools and techniques used in analysis.
- Understand the six sigma methodologies.
- Understand the implementation and challenges in six sigma.
- Understand the evaluation and continuous improvement methods
- Use the six sigma concepts in manufacturing sector.

REFERENCES:

1. Michael L.George, David Rownalds, Bill Kastle, What is Lean Six Sigma, McGraw – Hill 2003
2. Thomas Pyzdek, The Six Sigma Handbook, McGraw-Hill,2000
3. Fred Soleimannejed , Six Sigma, Basic Steps and Implementation, AuthorHouse, 2004
4. Forrest W. Breyfogle, III, James M. Cupello, Becki Meadows, Managing Six Sigma:A Practical Guide to Understanding, Assessing, and Implementing the Strategy That Yields Bottom-Line Success, John Wiley & Sons, 2000
5. James P. Womack, Daniel T.Jones, Lean Thinking, Free Press Business, 2003

OME505	ROBOTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Explaining the concepts of industrial robots with respect to its classification, specifications and coordinate systems. Reviewing the need and application of robots in different engineering fields.
- Exemplifying the different types of robot drive systems as well as robot end effectors.
- Applying the different sensors and image processing techniques in robotics to improve the ability of robots.
- Developing robotic programs for different tasks and analyzing the kinematics motions of robot.
- Implementing robots in various industrial sectors and interpolating 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 Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

UNIT III SENSORS AND MACHINE VISION 9

Transducers and Sensors – Sensor categories - Tactile array sensor – Touch -Proximity and range sensors – Compliance sensor – Sensing wrist forces - Sensing joint forces. Function of machine vision system – Sensing and Digitizing, Imaging devices – CCD – Videocon camera, Lighting techniques. Image Processing and Analysis – Image data reduction – segmentation – Feature extraction – Object recognition. Training of vision system.

UNIT IV ROBOT KINEMATICS AND ROBOT PROGRAMMING 9

Forward and Inverse kinematics of manipulator with two three Degrees of Freedom (DOF) in two-dimensional space – four degrees of freedom in three-dimensional space. (Elementary treatment only).Lead through Programming, Robot programming Languages-VAL Programming-Motion Commands, Sensor Commands, End Effector commands and simple Programs.

UNIT V IMPLEMENTATION AND ROBOT ECONOMICS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

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

- Illustrate the specifications of Industrial Robots. Also Draw the rectangular, polar, cylindrical and jointed arm configurations and work volume of Industrial robots.
- Draw and Illustrate the robot drive systems such as hydraulic, pneumatic, and electrical as well as robot end effectors
- Apply the analog and digital sensors and image processing techniques in robotics to improve the ability of robots.
- Develop robotic programs for manufacturing related tasks and familiarize with the kinematics motions of robot.
- Examine the implementation of robots in various industrial sectors and interpolate the economic analysis of robots using Pay-back period, Rate of Return on Investment methods.
- Apply the basic engineering knowledge for the design of industrial manipulators.

TEXT BOOKS:

1. Fu. K.S, Gonzalez. R.C, Lee. C.S.G “Robotics – Control, Sensing, Vision, and Intelligence”, McGraw Hill, 2015
2. Groover Mikell .P, “Industrial Robotics -Technology Programming and Applications”, McGraw Hill, 2014.

REFERENCES:

1. Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, 2009.
2. Deb S.R., “Robotics Technology and Flexible Automation” Tata McGraw Hill Book Co., 2013.
3. Koren Y., “Robotics for Engineers", McGraw Hill Book Co., 1992
4. Maja J Mataric, “The Robotics Primer “Universities Press. 2013.
5. Robin R. Murphy “ Introduction to AI Robotics” PHI Learning Private Limited, 2000.