P.S.R. ENGINEERING COLLEGE

(An Autonomous Institution & Affiliated to Anna University, Chennai)

M.E. Engineering Design

PG REGULATION-2012

CURRICULUM AND SYLLABI

[I To IV Semester]

THIS IS THE FINAL VERSION OF THE SYLLABUS AS APPROVED BY THE ACADEMIC COUNCIL OF THE COLLEGE IN THE MEETING HELD ON 1ST JUNE 2013

CURRICULUM AND SYLLABI FOR CANDIDATES ADMITTED

R-2012

BRANCH: M.E. ENGINEERING DESIGN

(Full Time)

SEMESTER I

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
12ED11	Applied Mathematics for Engineering Design	3	1	0	4
12ED12	Concepts of Engineering Design	3	0	0	3
12ED13	Computer Applications in Design	3	0	0	3
12ED14	Advanced Mechanics of Materials	3	1	0	4
E1	Elective I	3	0	0	3
E2	Elective II	3	0	0	3
PRACTICALS					
12ED17	CAD Laboratory	0	0	2	1
	TOTAL	**18**	**2**	**2**	**21**

SEMESTER II

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
12ED21	Finite Element Methods in Mechanical Design	3	1	0	4
12ED22	Vibration Analysis and Control	3	1	0	4
12ED23	Mechanisms Design and Simulation	3	1	0	4
12ED24	Tribology in Design	3	1	0	4
E3	Elective III	3	0	0	3
E4	Elective IV	3	0	0	3
PRACTICALS					
12ED27	Analysis and Simulation Laboratory	0	0	2	1
12ED28	Seminar	0	0	2	1
	TOTAL	**18**	**4**	**4**	**24**

SEMESTER III

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
E5	Elective V	3	0	0	3
E6	Elective VI	3	0	0	3
E7	Elective VII	3	0	0	3
12ED31	Project Work – Phase I	0	0	12	6
	TOTAL	**9**	**0**	**12**	**15**

SEMESTER IV

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
12ED41	Project Work – Phase II	0	0	24	12

- A term must be given for assignment – 3 (compulsory)

Total Number of Credits : 21 + 24 +15 + 12 = 72

ELECTIVE SUBJECTS

SEMESTER I

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
12ED1A	Optimization techniques in Design	3	0	0	3
12ED1B	Mechanical Behavior in Materials	3	0	0	3
12ED1C	Advanced Tool Design	3	0	0	3
12ED1D	Design for Manufacture Assembly & Environment	3	0	0	3
12ED1E	Design of Hydraulic and Pneumatic systems	3	0	0	3
12ED1F	Bearing Design and Rotor Dynamics	3	0	0	3
12ED1G	Creativity in Design	3	0	0	3
12ED1H	Advanced Machine Tool Design	3	0	0	3
12ED1I	Enterprise Resource Planning	3	0	0	3

SEMESTER II

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
12ED2A	Engineering Fracture Mechanics	3	0	0	3
12ED2B	Composite materials and Mechanics	3	0	0	3
12ED2C	Design of Pressure Vessel and Piping	3	0	0	3
12ED2D	Maintenance Engineering	3	0	0	3
12ED2E	Micro Electro Mechanical Systems	3	0	0	3
12ED2F	Plasticity and Metal Forming	3	0	0	3
12ED2G	Modal Analysis of Mechanical Systems	3	0	0	3
12ED2H	Design of Heat Exchangers	3	0	0	3
12ED2I	Productivity Management and Re-engineering	3	0	0	3

SEMESTER III

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
12ED3A	Quality Concepts in Design	3	0	0	3
12ED3B	Computational Fluid Dynamics	3	0	0	3
12ED3C	Industrial Robotics and Expert Systems	3	0	0	3
12ED3D	Design of Material Handling Equipments	3	0	0	3
12ED3E	Supply Chain Management	3	0	0	3
12ED3F	Rapid Prototyping and Tooling	3	0	0	3
12ED3G	Integrated Manufacturing Systems	3	0	0	3
12ED3H	Mechatronics in Manufacturing Systems	3	0	0	3
12ED3I	Reverse Engineering	3	0	0	3

12ED11	APPLIED MATHEMATICS FOR ENGINEERING DESIGN	L	T	P	C
		3	1	0	4

Aim

To develop the mathematical skill in the area of Applications in Engineering Design

Objective

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

- Understand Joint distributions and random variables
- Solve the Finite difference methods and – Numerical solution of partial differential equations
- Familiarize with the tensor analysis
- Understand the calculus of variation
- Use fast Fourier transform

UNIT I RANDOM VARIABLES 9 + 3

Joint distributions – Marginal and Conditional distributions – functions of two – dimensional random variables – Regression curve – Correlation.

UNIT II COMPUTATIONAL METHODS IN ENGINEERING 9 + 3

Boundary value problems for ODE – Finite difference methods – Numerical solution of PDE – Solution of Laplace's and Poisson equation – Liebmann's iteration process – Solution of heat conduction equation by Schmidt explicit formula and Crank-Nicolson implicit scheme – Solution of wave equation.

UNIT III TENSOR ANALYSIS 9 + 3

Summation convention – Contra variant and covariant vectors – contraction of tensors – inner product – quotient law – metric tensor – Christoffel symbols – covariant differentiation – gradient, divergence and curl.

UNIT IV CALCULUS OF VARIATION 9 + 3

Variation and its properties – Euler's equation – functionals dependent on first and higher order derivatives – functionals dependent on functions of several independent variables – problems with moving boundaries – direct methods – Ritz and Kantorovich methods.

UNIT V FAST FOURIER TRANSFORM 9 + 3

Discrete Fourier transform – linearity and periodicity – inverse N-point DFT – DFT approximation of Fourier coefficients – sampled Fourier series – Approximation of Fourier transform by an N-point DFT – FFT – Computational efficiency of FFT.

Total : 45 + 15 = 60 Periods

REFERENCES

1. *James, G., **"Advanced Modern Engineering Mathematics",** 3rd edition, Pearson Education, (2004)*
2. *Grewal, B.S., **"Numerical methods in Engineering and Science",** 7th edition, Khanna Publishers, (2005)*
3. *Grewal, B.S., **"Higher Engineering Mathematics",** 40th edition, Khanna Publishers, (2007)*
4. *Gupta, A.S., **"Calculus of variations with applications",** Prentice-Hall of India, New Delhi, (1997)*
5. *Andrews, L.C. and Philips, R. L. **"Mathematical Techniques for Engineers and Scientists",** Prentice Hall of India, (2006)*

12ED12	CONCEPTS OF ENGINEERING DESIGN	L	T	P	C
		3	0	0	3

Aim

To understand the basic steps involved in concept of engineering design

Objective

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

- Familiarize the various steps involved in the design process and fundamentals
- Develop the skills on ethical requirements and know about customer requirements
- Learn to know the design methods and optimization
- Understand the material selection process and design considerations
- Know the reliability in design

UNIT I DESIGN FUNDAMENTALS 9

Importance of design – The design process – Considerations of Good Design – Morphology of Design – Organization for design – Computer Aided Engineering – Designing to codes and standards – Concurrent Engineering – Product and process cycles – Technological Forecasting – Market Identification – Competition Bench marking.

UNIT II CUSTOMER ORIENTED DESIGN & SOCIETAL CONSIDERATIONS 9

Identification of customer needs – customer requirements – Quality Function Deployment – Product Design Specifications – Human Factors in Design – Ergonomics and Aesthetics – Societal consideration – Contracts – Product liability – Protecting intellectual property – Legal and ethical domains – Codes of ethics – Ethical conflicts – Environment responsible design – future trends in interaction of engineering with society.

UNIT III DESIGN METHODS 9

Creativity and Problem Solving – Creativity methods – Theory of Inventive Problem Solving (TRIZ) – Conceptual decomposition – Generating design concepts – Axiomatic Design – Evaluation methods – Embodiment Design – Product Architecture – Configuration Design – Parametric Design – Role of models in design – Mathematical Modeling – Simulation – Geometric Modeling –Rapid prototyping – Finite Element Analysis – Optimization – Search Methods.

UNIT IV MATERIAL SELECTION PROCESSING AND DESIGN 9

Material Selection Process – Economics – Cost vs Performance – Weighted property Index – Value Analysis – Role of Processing in Design – Classification of Manufacturing Process – Design for Manufacture – Design for Assembly – Designing for castings, Forging, Metal Forming, Machining and Welding – Residual Stresses – Fatigue, Fracture and Failure.

UNIT V PROBABILITY CONCEPTS IN DESIGN FOR RELIABILITY 9

Probability – Distributions – Test of Hypothesis – Design of Experiments – Reliability Theory – Design for Reliability – Reliability centered Maintenance – Robust Design – Failure mode Effect Analysis.

Total : 45 Periods

REFERENCES

1. *Pahl, G, and Beitz, W.,* ***"Engineering Design",*** *Springer, Verlag, NY. (1984)*
2. *Ray, M.S.,* ***"Elements of Engineering Design",*** *Prentice Hall Inc. (1985)*
3. *Suh, N.P.,* ***"The principles of Design",*** *Oxford University Press, NY. (1990)*
4. *Karl T. Ulrich and Steven D. Eppinger* ***"Product Design and Development"*** *McGraw Hill Edition (2000)*
5. *Mark N. Horenstein "****Design concepts for engineers",*** *Prentice Hall, (2010)*

12ED13	COMPUTER APPLICATIONS IN DESIGN	L	T	P	C
		3	0	0	3

Aim

To impart knowledge in Computer Graphics, Solid Modeling and also in CAD software

Objectives

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

- Illustrate the Computer Graphics Fundamentals like Curves, boundary models etc.,
- Understand the languages like Auto LISP/C
- Work in Data exchange standards & Solid Geometry
- Facilitates the Parametric and Variational geometry based software
- Explain the Tolerance analysis & Assembly modeling

UNIT I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS 10

Output primitives (points, lines, curves etc.,), 2-D & 3-D transformation (Translation, scaling, rotators) windowing – view ports – clipping transformation – Representation of curves – Bezier curves – cubic spline curve – B-Spline curves – Rational curves – Surface Modeling techniques – surface patch – Coons patch– bi-cubic patch – Bezier and B-spline surfaces – Volume modeling – Boundary models – CSG – other modeling techniques.

UNIT II INTRODUCTION TO CAD SOFTWARE 10

Writing interactive programs to solve design problems and production of drawings – using any languages like Auto LISP/C/FORTRAN etc., – creation of surfaces – solids etc., using solid modeling packages (prismatic and revolved parts).

UNIT III SOLID MODELING 8

Regularized Boolean set operations – primitive instancing – sweep representations – boundary representations – constructive solid Geometry – comparison of representations – user interface for solid modeling – Graphics and computing standards – Open GL Data Exchange standards – IGES, STEP etc., – Communication standards.

UNIT IV VISUAL REALISM 9

Hidden – Line – Surface – solid removal algorithms shading – coloring – Introduction to parametric and variational geometry based software's and their principles creation of prismatic and lofted parts using these packages.

UNIT V ASSEMBLY OF PARTS 8

Assembly modeling – interferences of positions and orientation – tolerances analysis – mass property calculations – mechanism simulation.

Total : 45 Periods

REFERENCES

1. *William M Neumann and Robert F.Sproul,* ***"Principles of Computer Graphics",*** *McGraw Hill Book Co. Singapore, (1989)*
2. *Donald Hearn and M. Pauline Baker* ***"Computer Graphics",*** *Prentice Hall, Inc., (1992)*
3. *Ibrahim Zeid* ***"CAD/CAM",*** *Tata McGraw Hill, International Edition, (2007)*
4. *Foley, Wan Dam, Feiner and Hughes* ***"Computer graphics principles & practices",*** *Pearson Education (2003)*
5. *Duncan Marsh,* ***"Applied Geometry for Computer Graphics and CAD",*** *Springer, 2nd edition, (2005)*

12ED14	ADVANCED MECHANICS OF MATERIALS	L	T	P	C
		3	1	0	4

Aim

To gain the knowledge about the Mechanics of materials in advanced level

Objectives

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

- Understand the basic fundamentals of Elasticity
- Determine the stresses for various cross sectional members
- Know about the differences between straight beams and curved beams
- Familiarize with the torsion of non circular cross sectional members
- Gain the knowledge on stresses induced in rotating members

UNIT I ELASTICITY 9 + 3

Stress-Strain relations and general equations of elasticity in Cartesian, Polar and curvilinear coordinates, differential equations of equilibrium – compatibility – boundary conditions – representation of three-dimensional stress of a tension generalized hook's law – St. Venant's principle – plane stress – Airy's stress function – Energy methods.

UNIT II SHEAR CENTER AND UNSYMMETRICAL BENDING 10 + 3

Location of shear center for various thin sections – shear flows – Stresses and Deflections in beams subjected to unsymmetrical loading – kern of a section.

UNIT III CURVED FLEXIBLE MEMBERS AND STRESSES IN FLAT PLATES 10 + 3

Circumference and radial stresses – deflections – curved beam with restrained ends – closed ring subjected to concentrated load and uniform load – chain links and crane hooks – Solution of rectangular plates – pure bending of plates – deflection – uniformly distributed load – various end conditions.

UNIT IV TORSION OF NON-CIRCULAR SECTIONS 7 + 3

Torsion of rectangular cross section – St.Venants theory – elastic membrane analogy – Prandtl's stress function – torsional stress in hollow thin walled tubes.

UNIT V STRESSES IN ROTARY SECTIONS AND CONTACT STRESSES 9 + 3

Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness allowable speeds. Methods of computing contact stress – deflection of bodies in point and line contact applications.

Total : 45 + 15 = 60 Periods

REFERENCES

1. *Arthur P Boresi, Richard J. Schmidt,* ***"Advanced mechanics of materials",*** *John Wiley, (2002)*
2. *Timoshenko and Goodier,* ***"Theory of Elasticity",*** *McGraw Hil, 3rd edition, (2010)*
3. *Robert D. Cook, Warren C. Young,* ***"Advanced Mechanics of Materials",*** *Mc-millan pub. Co., (1985)*
4. *Srinath. L.S.,* ***"Advanced Mechanics of solids",*** *Tata McGraw Hill, (1992)*
5. *Borg.S.F.,* ***"Matrix-Tensor methods in continuum Mechanics",*** *World Scientific pub. Co., 2nd edition, (1990)*

12ED17	CAD LAB	L	T	P	C
		0	0	2	1

- CAD Introduction
- Sketcher
- Solid modeling – Extrude, Revolve, Sweep, etc and Variational sweep, Loft, etc.,
- Surface modeling – Extrude, Sweep, Trim etc., and Mesh of curves, Free form etc.,
- Feature manipulation – Copy, Edit, Pattern, Suppress, History operations etc.,
- Assembly – Constraints, Exploded Views, Interference check
- Drafting – Layouts, Standard & Sectional Views, Detailing & Plotting

SYSTEM REQUIRMENTS
(for a batch of 25 Students)

Description of Equipment	Quantity Required
HARDWARE	
Computer Server	1 No.
Computer System	30 Nos.
17" VGA Color Monitor	
Pentium IV Processor	
40 GB HDD	
512 MB RAM	
Color Desk Jet Printer	1 No.
SOFTWARE	
Suitable modeling software like Pro-E/Solid Works/Solid Edge/CATIA	25 licenses

Total : 45 Periods

12ED21	FINITE ELEMENT METHODS IN MECHANICAL DESIGN	L	T	P	C
		3	1	0	4

Aim

To introduce the fundamentals of vibrations finite element methods used in mechanical design.

Objectives

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

- Study the general steps in finite element analysis and derive the basic finite element equation
- Study the various finite element methods, concepts, types of elements and element matrices
- Solve the linear elasticity problems in the field of heat transfer and fluid mechanics.
- Assemble the finite element structural dynamics and vibrational matrices, and also determine the design response to those conditions
- Solve the transient non-linear problems and find out the stresses and strains through post processing.

UNIT I GENERAL INTRODUCTION 10 + 3

Introduction – structural element and system – assembly and analysis of a structure – boundary conditions – general pattern – standard discrete system – transformation of coordinates – examples – direct physical approach to problems in elasticity – direct formulation – displacement approach – minimization of total potential – convergence criteria – discretization error – nonconforming elements and patch test – solution process.

UNIT II GENERALIZATION OF FINITE ELEMENT CONCEPTS AND ELEMENT SHAPE FUNCTIONS 7 + 3

Boundary value problems – integral or weak statements – weighted residual methods – Galerkin method – virtual work as weak form of equations in solid and fluid mechanics – variational principles – establishment of natural variational principles for linear self-adjoint differential equations – standard and hierarchical elements – shape functions – rectangular elements – completeness of polynomials – Lagrange family – Serendipity family – rectangular prisms – tetrahedral elements – global and local finite element approximation – mapped elements – coordinate transformations – geometrical conformity of elements – evaluation of element matrices – order of convergence – numerical integration.

UNIT III APPLICATIONS TO FIELD PROBLEMS 9 + 3

Solution to problems in linear elasticity – plane problems in elasticity – plates and shells – solution of problems in heat-transfer and fluid mechanics – numerical examples – discussion on error estimates.

UNIT IV FINITE ELEMENTS IN STRUCTURAL DYNAMICS AND VIBRATIONS 10 + 3

Dynamic equations – stiffness, mass and damping matrices – consistent and diagonal mass matrices – Extraction of natural frequencies and modes – Reduction of number of degrees of freedom – modal methods – component mode synthesis – harmonic analysis – response history – explicit and implicit direct integration – stability and accuracy – analysis of response spectra.

UNIT V NON-LINEAR ANALYSIS 9 + 3

Non-linear problems in elasticity – some solution methods – plasticity: introduction, general formulation for small strains – formulation for von Mises theory – computational procedure – problems of gaps and contact – geometric non-linearity – modelling considerations.

Total : 45 + 15 = 60 Periods

REFERENCES

1. Cook, R.D., Malkus, D. S., Plesha,M.E., and Witt,R.J., “Concepts and Applications of Finite Element Analysis”, Wiley Student Edition, 4th Edition, New Delhi, 1st Reprint (2007)
2. Zienkiewicz.O.C, Taylor.R.L., “The Finite Element Method”, McGraw Hill International Editions, 4th Edition, Volume 2, (1991)
3. Ramamurthi, V., “Finite Element Method in Machine Design”, Narosa Publishing House, (2009)
4. Huebner, K.H., Dewhirst, D.L., Smith, D.E & Byron,T.G., “The Finite Element Method for Engineers”, Wiley Student Edition, 4 th Edition, John Wiley & Sons Pvt. Ltd., (2004)
5. Charles E.Knight, “The Finite Element Method in Mechanical Design”, PWS-Kent publishing company, (1993)

12ED22	VIBRATION ANALYSIS AND CONTROL	L	T	P	C
		3	1	0	4

Aim

To introduce the fundamentals of vibrations, study effect of vibration of different degree of freedom systems.

Objectives

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

- Study the fundamentals of vibrations
- Understand the vibrations of different degrees of freedom system
- Know the methods of vibration analysis, controlling the effect of vibration.
- Discuss the effect of vibrations on important mechanical elements
- Understand the types of vibration measuring instruments

UNIT I FUNDAMENTALS OF VIBRATION 9 + 3

Introduction – Sources of Vibration – Mathematical Models – Displacement, velocity and Acceleration – Review of Single Degree Freedom Systems – Vibration isolation, Vibrometers and accelerometers – Response to Arbitrary and non-harmonic Excitations – Transient Vibration –Impulse loads – Critical Speed of Shaft – Rotor systems.

UNIT II TWO DEGREE FREEDOM SYSTEM 8 + 3

Identification of customer needs – customer requirements – Quality Function Deployment – Product Design Specifications – Human Factors in Design – Ergonomics and Aesthetics.

UNIT III MULTI-DEGREE FREEDOM SYSTEM AND CONTINUOUS SYSTEM 9 + 3

Multi Degree Freedom System – Influence Coefficients and stiffness coefficients – Flexibility Matrix and Stiffness Matrix – Eigen Values and Eigen Vectors – Matrix Iteration Method – Approximate Methods: Dunkerley, Rayleigh's, and Holzer Method – Geared Systems – Eigen Values & Eigen vectors for large system of equations using sub space, Lanczos method – Continuous System: Vibration of String, Shafts and Beams.

UNIT IV VIBRATION CONTROL 9 + 3

Specification of Vibration Limits – Vibration severity standards – Vibration as condition Monitoring tool – Vibration Isolation methods – Dynamic Vibration Absorber, Torsional and Pendulum Type Absorber – Damped Vibration absorbers – Static and Dynamic Balancing – Balancing machines – Field balancing – Vibration Control by Design Modification – Active Vibration Control.

UNIT V EXPERIMENTAL METHODS IN VIBRATION ANALYSIS 10 + 3

Vibration Analysis Overview – Experimental Methods in Vibration Analysis – Vibration Measuring Instruments – Selection of Sensors – Accelerometer Mountings – Vibration Exciters – Mechanical, Hydraulic, Electromagnetic and Electrodynamics – Frequency Measuring Instruments – System Identification from Frequency Response – Testing for resonance and mode shapes.

Total : 45 + 15 = 60 Periods

REFERENCES

1. *Rao, S.S.,* ***"Mechanical Vibrations",*** *Addison Wesley Longman, (1995)*
2. *Thomson, W.T.,* ***"Theory of Vibration with Applications",*** *CBS Publishers and Distributors, New Delhi, (1990)*
3. *Ramamurti, V.,* ***"Mechanical Vibration Practice with Basic Theory",*** *Narosa, New Delhi, (2000)*
4. *Graham Kelly, S. & Shashidar K. Kudari,* ***"Mechanical Vibrations",*** *Tata McGraw Hill Publishing, New Delhi, (2007)*
5. *Daniel J. Inman,* ***"Vibration with Control",*** *John Wiley & sons Ltd., England, (2006)*

12ED23	MECHANISMS DESIGN AND SIMULATION	L	T	P	C
		3	1	0	4

Aim

To impart knowledge in Mechanisms Design, Kinematic analysis and Simulation.

Objectives

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

- Understand the basics of mechanisms
- Explain the kinematics of linkages
- Understand the path curvature theory
- Facilitate the four bar mechanism function by graphical methods
- Explain the CAM mechanism

UNIT I INTRODUCTION 9 + 3

Review of fundamentals of kinematics – classifications of mechanisms – components of mechanisms – mobility analysis – formation of one D.O.F. multi loop kinematic chains, Network formula – Gross motion concepts – Basic kinematic structures of serial and parallel robot manipulators – Compliant mechanisms – Equivalent mechanisms.

UNIT II KINEMATIC ANALYSIS 9 + 3

Position Analysis – Vector loop equations for four bar, slider crank, inverted slider crank, geared five bar and six bar linkages – Analytical methods for velocity and acceleration Analysis – four bar linkage jerk analysis – Plane complex mechanisms – auxiliary point method – Spatial RSSR mechanism – Denavit – Hartenberg Parameters – Forward and inverse kinematics of robot manipulators.

UNIT III PATH CURVATURE THEORY, COUPLER CURVE 9 + 3

Fixed and moving centrodes, inflection points and inflection circle – Euler Savary equation, graphical constructions – cubic of stationary curvature – Four bar coupler curve.

UNIT IV SYNTHESIS OF FOUR BAR MECHANISMS 9 + 3

Type synthesis – Number synthesis – Associated Linkage Concept – Dimensional synthesis – function generation, path generation, motion generation – Graphical methods – Pole technique – inversion technique – point position reduction – two, three and four position synthesis of four-bar mechanisms – Analytical methods – Freudenstein's Equation – Bloch's Synthesis.

UNIT V SYNTHESIS OF COUPLER CURVE BASED MECHANISMS & CAM MECHANISMS 9 + 3

Cognate Linkages – parallel motion Linkages – Design of six bar mechanisms – single dwell – double dwell – double stroke – Geared five bar mechanism – multi-dwell – Cam Mechanisms – determination of optimum size of cams – Mechanism defects.

Total : 45 + 15 = 60 Periods

REFERENCES

1. *Robert L.Norton., **"Design of Machinery"**, Tata McGraw Hill, (2005)*
2. *Sandor G.N., and Erdman A.G., **"Advanced Mechanism Design Analysis and Synthesis"**, Prentice Hall, (1984)*
3. *Uicker, J.J., Pennock, G. R. and Shigley, J.E., **"Theory of Machines and Mechanisms"**, Oxford University Press, (2005)*
4. *Amitabha Ghosh and Asok Kumar Mallik, **"Theory of Mechanism and Machines"**, EWLP, Delhi, (1999)*
5. *Kenneth J, Waldron, Gary L. Kinzel, **"Kinematics, Dynamics and Design of Machinery"**, John Wiley & sons, (1999)*

12ED24	TRIBOLOGY IN DESIGN	L	T	P	C
		3	1	0	4

Aim

To study about the friction and various types of lubrication between different materials

Objectives

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

- Understand the types of friction and surface interaction
- Understand Mechanism of various types of wear and surface treatments
- Know the types of lubrication processes
- Familiarize the various lubricant standards.
- Describe the high pressure contacts and the theory of elasto hydrodynamic lubrication

UNIT I SURFACE INTERACTION AND FRICTION 7 + 3

Topography of Surfaces – Surface features – Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction – Rolling Friction – Friction properties of metallic and non-metallic materials – friction in extreme conditions –Thermal considerations in sliding contact.

UNIT II WEAR AND SURFACE TREATMENT 8 + 3

Types of wear – Mechanism of various types of wear – Laws of wear –Theoretical wear models – Wear of Metals and Non metals – Surface treatments – Surface modifications – surface coatings methods – Surface Topography measurements – Laser methods – instrumentation – International standards in friction and wear measurements.

UNIT III LUBRICANTS AND LUBRICATION REGIMES 8 + 3

Lubricants and their physical properties – Viscosity and other properties of oils – Additives and selection of Lubricants – Lubricants standards ISO,SAE,AGMA,BIS standards – Lubrication Regimes – Solid Lubrication – Dry and marginally lubricated contacts – Boundary Lubrication – Hydrodynamic lubrication – Elasto and plasto hydrodynamic – Magneto hydrodynamic lubrication – Hydro static lubrication – Gas lubrication.

UNIT IV THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION 12 + 3

Reynolds Equation – Assumptions and limitations – one and two dimensional Reynolds Equation – Reynolds and Sommerfeld boundary conditions – Pressure wave, flow, load capacity and friction calculations in Hydrodynamic bearings – Long and short bearings – Pad bearings and Journal bearings – Squeeze film effects – Thermal considerations – Hydrostatic lubrication of Pad bearing – Pressure, flow, load and friction calculations – Stiffness considerations – Various types of flow restrictors in hydrostatic bearings.

UNIT V HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION 10 + 3

Rolling contacts of Elastic solids – contact stresses – Hertzian stress equation – Spherical and cylindrical contacts – Contact Fatigue life – Oil film effects – Elasto Hydrodynamic lubrication Theory – Soft and hard EHL – Reynolds equation for elasto hydrodynamic lubrication – Film shape within and outside contact zones – Film thickness and friction calculation – Rolling bearings – Stresses and deflections – Traction drives.

Total : 45 + 15 = 60 Periods

REFERENCES

1. *Rabinowicz.E, **"Friction and Wear of materials"**, John Willey &Sons ,UK,(1995)*
2. *Cameron, A. **"Basic Lubrication Theory"**, Ellis Herward Ltd., UK, (1981)*
3. *Halling, J. (Editor) **"Principles of Tribology"**, Macmillian, (1984)*
4. *Williams J.A. **"Engineering Tribology"**, Oxford Univ. Press, (1994)*
5. *K.Basu, S.N.Sengupta & B.B.Ahuja ., **"Fundamentals of Tribology"**, Prentice –Hall of India Pvt. Ltd , New Delhi, (2005)*

12ED27	ANALYSIS AND SIMULATION LABORATORY	L	T	P	C
		0	0	2	1

Analysis of Mechanical Components – Use of FEA Packages like ANSYS/ NASTRAN etc., Exercises shall include analysis of

i) Machine elements under Static loads

ii) Thermal Analysis of mechanical systems

iii) Modal Analysis

iv) Machine elements under Dynamic loads

v) Non Linear Systems

Use of kinematics and dynamics simulation software like ADAMS, MATLAB to analyze the velocity and acceleration of mechanical linkages of different mechanisms.

SYSTEM REQUIRMENTS
(for a batch of 25 Students)

Description of Equipment	Quantity Required
HARDWARE	
Computer Server	1 No.
Computer System 30	
17" VGA Color Monitor Pentium IV Processor 40 GB HDD 512 MB RAM	25 Nos.
Color Desk Jet Printer	1 No.
SOFTWARE	
Suitable analysis software	25 licenses
C / MATLAB	5 licenses

Total : 45 Periods

ELECTIVE SUBJECTS

12ED1A	OPTIMIZATION TECHNIQUES IN DESIGN	L	T	P	C
		3	0	0	3

Aim

To describe the concept and principles of optimization techniques in design.

Objective

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

- Understand the techniques and application of optimization design.
- Know the constrained techniques in optimization.
- Develop the knowledge of Neural network & Fuzzy logic principles in optimization.
- Understand the design of shaft and structural applications.
- Apply the design of simple linkage mechanisms.

UNIT I UNCONSTRAINED OPTIMIZATION TECHNIQUES 10

Introduction to optimum design – General principles of optimization – Problem formulation & their classifications – Single variable and multivariable optimization, Techniques of unconstrained minimization – Golden section, Random, pattern and gradient search methods – Interpolation methods.

UNIT II CONSTRAINED OPTIMIZATION TECHNIQUES 10

Optimization with equality and inequality constraints – Direct methods – Indirect methods using penalty functions, Lagrange multipliers – Geometric programming.

UNIT III ADVANCED OPTIMIZATION TECHNIQUES 10

Multi stage optimization – dynamic programming, stochastic programming, Multi objective optimization, Genetic algorithms and Simulated Annealing techniques, Neural network & Fuzzy logic principles in optimization.

UNIT IV STATIC APPLICATIONS 8

Structural applications – Design of simple truss members – Design applications – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members – Design of springs.

UNIT V DYNAMIC APPLICATIONS 7

Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers – Application in Mechanisms – Optimum design of simple linkage mechanisms.

Total : 45 Periods

REFERENCES

1. *Rao, Singaresu, S.,* ***"Engineering Optimization – Theory & Practice"****, New Age International (P) Limited, New Delhi, (2000)*
2. *Johnson Ray, C.,* ***"Optimum design of mechanical elements"****, Wiley, John & Sons, (1990)*
3. *Kalyanamoy Deb,* ***"Optimization for Engineering design algorithms and Examples"****, Prentice Hall of India Pvt. (1995)*
4. *Goldberg, D.E.,* ***"Genetic algorithms in search, optimization and machine"****, Barnen, Addison-Wesley, New York, (1989)*
5. *Garret N. Vanderplaats,* ***"Numerical Optimization techniques for engineering design with applications",*** *McGraw Hill Ryerson ltd., (1984)*

12ED1B	MECHANICAL BEHAVIOR OF MATERIALS	L	T	P	C
		3	0	0	3

Aim

To impart the knowledge about production techniques and applications of materials

Objectives

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

- Understand the basic concepts of material behavior.
- Know the material behavior under dynamic loads.
- Select the materials for various applications
- Study the properties and applications of modern metallic materials.
- Understand the production techniques and applications of non-metallic material.

UNIT I BASIC CONCEPTS OF MATERIAL BEHAVIOR 10

Elasticity in metals and polymers – Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening – Effect of temperature, strain and strain rate on plastic behaviour – Super plasticity –. Griffith's theory – Ductile, brittle transition in steel – High temperature fracture, creep – Larson Miller parameter – Deformation and fracture mechanism maps.

UNIT II BEHAVIOUR UNDER DYNAMIC LOADS AND DESIGN APPROACHES 10

Stress intensity factor and fracture toughness – Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law.- Safe life, Stress-life, strain-life and fail - safe design approaches - Effect of surface and metallurgical parameters on fatigue – Fracture on non metallic materials – Failure analysis, sources of failure, procedure of failure analysis.

UNIT III SELECTION OF MATERIALS 10

Motivation for selection, cost basis and service requirements – Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications – Computer aided materials selection.

UNIT IV MODERN METALLIC MATERIALS 8

Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel – Intermetallics, Ni and Ti aluminides – smart materials, shape memory alloys – Metallic glass and nano crystalline materials.

UNIT V NON METALLIC MATERIALS 7

Polymeric materials – Formation of polymer structure – Production techniques fibers, foams, adhesives and coating – structure, properties and engineering polymers – Advanced structural ceramics, WC, SiC, Si3N4, CBN and diamond – properties, processing and applications.

otal : 45 Periods

REFERENCES

1. *George E. Dieter,* ***"Mechanical Metallurgy",*** *McGraw Hill, (1988)*
2. *Thomas H. Courtney,* ***"Mechanical Behavior of Materials",*** *2nd edition, McGraw Hill, (2000)*
3. *Charles, J.A., Crane, F.A.A. and Fumess, J.A.G.,* ***"Selection and use of engineering materials",*** *3rd edition, Butterworth-Heiremann, (1997)*
4. *Flinn, R.A., and Trojan, P.K.,* ***"Engineering Materials and their Applications",*** *4th Edition, Jaico, (1999)*
5. *Metals Hand book, Vol.10,* ***"Failure Analysis and Prevention",*** *10th Edition, Jaico, (1999)*

12ED1C ADVANCED TOOL DESIGN L T P C
3 0 0 3

Aim

To study the various factors that enhances the designing of product regarding manufacturing, assembly and environment.

Objectives

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

- Study the general design principles of component design.
- Understand the factors that influences the form design
- Discuss the design features to facilitate machining.
- Describe the design factors that influencing the redesign of casting
- Design of components for environment, assembly.

UNIT I INTRODUCTION TO TOOL DESIGN 8

Introduction – Tool Engineering – Tool Classifications – Tool Design Objectives – Tool Design in manufacturing – Challenges and requirements – Standards in tool design – Tool drawings – Surface finish – Fits and Tolerances – Tooling Materials – Ferrous and Non ferrous Tooling Materials – Carbides, Ceramics and Diamond – Non metallic tool materials – Designing with relation to heat treatment.

UNIT II DESIGN OF CUTTING TOOLS 9

Mechanics of Metal cutting – Oblique and orthogonal cutting – Chip formation and shear angle – Single – point cutting tools – Milling cutters – Hole making cutting tools – Broaching Tools – Design of Form relieved and profile relieved cutters – Design of gear and thread milling cutters.

UNIT III DESIGN OF JIGS AND FIXTURES 10

Introduction – Fixed Gages – Gage Tolerances – selection of material for Gages – Indicating Gages – Automatic gages – Principles of location – Locating methods and devices – Principles of clamping – Drill jigs – Chip formation in drilling – General considerations in the design of drill jigs – Drill bushings – Methods of construction – Thrust and Turning Moments in drilling – Drill jigs and modern manufacturing – Types of Fixtures – Vise Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures – Lathe Fixtures – Grinding Fixtures – Modular Fixtures – Cutting Force Calculations.

UNIT IV DESIGN OF PRESS TOOL DIES 10

Types of Dies – Method of Die operation – Clearance and cutting force calculations – Blanking and Piercing die design – Pilots – Strippers and pressure pads – Presswork materials – Strip layout – Short-run tooling for Piercing – Bending dies – Forming dies – Drawing dies – Design and drafting.

UNIT V TOOL DESIGN FOR CNC MACHINE TOOLS 8

Introduction –Tooling requirements for Numerical control systems – Fixture design for CNC machine tools – Sub plate and tombstone fixtures – Universal fixtures – Cutting tools – Tool holding methods – Automatic tool changers and tool positioners – Tool presetting – General explanation of the Brown and Sharp machine.

Total: 45 Periods

REFERENCES

1. *Cyrll Donaldson, George H.LeCain, V.C. Goold, **"Tool Design"**, Tata McGraw Hill Publishing Company Ltd., (2000)*
2. *Hoffman, E.G., **"Jigs and Fixture Design"**, Thomson Asia Pvt Ltd, Singapore, (2004)*
3. *Prakash Hiralal Joshi, **"Tooling data"**, Wheeler Publishing, (2000)*
4. *Venkataraman K., **"Design of Jigs, Fixtures and Presstools"**, TMH, (2005)*
5. *Haslehurst M., **"Manufacturing Technology"**, The ELBS, (1978)*

12ED1D DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENTS

L	T	P	C
3	0	0	3

Aim

To study the various factors that enhances the designing of product regarding manufacturing, assembly and environment.

Objectives

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

- Describe the general design principles for manufacturability.
- Understand the factors that influencing form design.
- Familiarize the design features to facilitate machining.
- Describe the design factors that influencing the redesign of casting.
- Know the techniques to reduce environmental impact of a product.

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.

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 DESIGN FOR THE ENVIRONMENT 9

Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT&T's environmentally responsible product assessment – Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly – Design for recyclability – Design for remanufacture – Design for energy efficiency – Design to regulations and standards.

Total : 45 Periods

REFERENCES

1. *Boothroyd, G,* ***"Design for Assembly Automation and Product Design"****, New York, (1980)*
2. *Dekker. Marcel Bralla,* ***"Design for Manufacture handbook"****, McGraw hill, (1999)*
3. *Boothroyd, G, Heartz and Nike,* ***"Product Design for Manufacture"****, Marcel Dekker, (1994)*
4. *Dickson, John. R, and Corroda Poly,* ***"Engineering Design and Design for Manufacture and Structural Approach"****, Field Stone Publisher, USA, (1995)*
5. *Kevien Otto and Kristin Wood,* ***"Product Design"****, Pearson Publication, (2004)*

12ED1E	DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS	L	T	P	C
		3	0	0	3

Aim

To obtain a brief knowledge on the function, installation and maintenance of the hydraulic and pneumatic circuits

Objectives

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

- Identify the selection, specification and characteristics of the actuators
- Know the functions of Pressure, direction and flow control valves
- Design different hydraulic circuits for various applications
- Knows the pneumatic systems and to design the circuits by various methods
- Attain knowledge on installation and maintenance of the circuits

UNIT I OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS 8

Hydraulic Power Generators – Selection and specification of pumps, pump characteristics – Linear and Rotary Actuators – selection, specification and characteristics.

UNIT II CONTROL AND REGULATION ELEMENTS 8

Pressure – direction and flow control valves – relief valves, non-return and safety valves – actuation systems.

UNIT III HYDRAULIC CIRCUITS 8

Reciprocation, quick return, sequencing, synchronizing circuits – accumulator circuits – industrial circuits – press circuits – hydraulic milling machine – grinding, planning, copying – forklift, earth mover circuits – design and selection of components – safety and emergency mandrels.

UNIT IV PNEUMATIC SYSTEMS AND CIRCUITS 12

Pneumatic fundamentals – control elements, position and pressure sensing – logic circuits – switching circuits – fringe conditions modules and these integration – sequential circuits – cascade methods – mapping methods – step counter method – compound circuit design – combination circuit design.

UNIT V INSTALLATION, MAINTENANCE AND SPECIAL CIRCUITS 9

Pneumatic equipments – selection of components – design calculations – application – fault finding – hydro pneumatic circuits – use of microprocessors for sequencing – PLC, Low cost automation – Robotic circuits.

Total : 45 Periods

REFERENCES

1. *Antony Espossito,* ***"Fluid Power with Applications"****, Prentice Hall, (1980)*
2. *Dudleyt, A. Pease and John J. Pippenger,* ***"Basic fluid power"****, Prentice Hall, (1987)*
3. *Andrew Parr,* ***"Hydraulic and Pneumatics"*** *(HB), Jaico Publishing House, (1999)*
4. *Bolton. W.,* ***"Pneumatic and Hydraulic Systems"****, Butterworth – Heinemann, (1997)*
5. *Shanmuga Sundaram, K.,* ***"Hydraulic and Pneumatic Controls: Understanding made Easy"****, S.Chand & Co Book publishers, New Delhi, (2009)*

12ED1F	BEARING DESIGN AND ROTOR DYNAMICS	L	T	P	C
		3	0	0	3

Aim

To study the design principles of bearing and its roto dynamic applications

Objective

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

- Familiarize the various steps involved in design process
- Understand the selection and design process of bearings.
- Know the bearing materials and its applications.
- Analyze the dynamic conditions of bearings using finite element analysis.
- Analyze the dynamic mechanics of bearings.

UNIT I CLASSIFICATION AND SELECTION OF BEARINGS 8

Selection criteria – Dry and Boundary Lubrication Bearings – Hydrodynamic and Hydrostatic bearings – Electro Magnetic bearings – Dry bearings – Rolling Element bearings – Bearings for Precision Applications – Foil Bearings – Special bearings – Selection of plain Bearing materials – Metallic and Non metallic bearings.

UNIT II DESIGN OF FLUID FILM BEARINGS 9

Design and performance analysis of Thrust and Journal bearings – Full, partial, fixed and pivoted journal bearings design procedure – Minimum film thickness – lubricant flow and delivery – power loss, Heat and temperature distribution calculations – Design based on Charts & Tables and Experimental curves – Design of Foil bearings – Air Bearings – Design of Hydrostatic bearings – Thrust and Journal bearings – Stiffness consideration – flow regulators and pump design.

UNIT III SELECTION AND DESIGN OF ROLLING BEARINGS 9

Contact Stresses in Rolling bearings – Centrifugal stresses – Elasto hydrodynamic lubrication – Fatique life calculations – Bearing operating temperature – Lubrication – Selection of lubricants – Internal clearance – Shaft and housing fit – Mounting arrangements – Materials for rolling bearings – Manufacturing methods – Ceramic bearings – Rolling bearing cages – bearing seals selection.

UNIT IV DYNAMICS OF HYDRODYNAMIC BEARINGS 10

Hydrodynamic Lubrication equation for dynamic loadings – Squeeze film effects in journal bearings and thrust bearings – Rotating loads, alternating and impulse loads in journal bearings – Journal centre Trajectory – Analysis of short bearings under dynamic conditions – Finite difference solution for dynamic condition.

UNIT V ROTOR DYNAMICS 9

Rotor vibration and Rotor critical speeds – support stiffness on critical speeds – Stiffness and damping coefficients of journal bearings – computation and measurements of journal bearing coefficients – Mechanics of Hydro dynamic Instability – Half frequency whirl and Resonance whip – Design configurations of stable journal bearings.

Total : 45 Periods

REFERENCES

1. *Neale, M.J., "Tribology Hand Book", Butterworth Heinemann, U.K. (2001)*
2. *Cameron, A.* ***"Basic Lubrication Theory"****, Ellis Herward Ltd., UK, (1981)*
3. *Halling, J. (Editor) –* ***"Principles of Tribology"****, Macmillian (1984)*
4. *Williams J.A.,* ***"Engineering Tribology"****, Oxford Univ. Press, (1994)*
5. *Basu, S.K., Sengupta, S.N., & Ahuja, B.B., "****Fundamentals of Tribology****", Prentice Hall of India Pvt Ltd , New Delhi, (2005)*

12ED1G	CREATIVITY IN DESIGN	L	T	P	C
		3	0	0	3

Aim

To improve the creative knowledge in design field

Objective

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

- Understand the need of creativity for a design engineer
- Know the visualization techniques for designing
- Familiarize the tools for creative design and innovativeness
- Describe the types of creative design like Process design and emotional design etc.,
- Study to develop innovative technology though TRIZ

UNIT I INTRODUCTION 4

Need for design creativity – creative thinking for quality – essential theory about directed creativity.

UNIT II MECHANISM OF THINKING AND VISUALIZATION 11

Definitions and theory of mechanisms of mind heuristics and models: attitudes, Approaches and Actions that support creative thinking – Advanced study of visual elements and principles – line, plane, shape, form, pattern, texture gradation, color symmetry – Spatial relationships and compositions in 2 and 3 dimensional space – procedure for genuine graphical computer animation – Animation aerodynamics – virtual environments in scientific Visualization – Unifying principle of data management for scientific visualization – Unifying principle of data management for scientific visualization – Visualization benchmarking.

UNIT III CREATIVITY 11

Methods and tools for Directed Creativity – Basic Principles – Tools of Directed Creativity – Tools that prepare the mind for creative thought – stimulation of new ideas – Development and Actions – Processes in creativity ICEDIP – Inspiration, Clarification, Distillation, Perspiration, Evaluation and Incubation – Creativity and Motivation – The Bridge between man creativity and the rewards of innovativeness – Applying Directed Creativity to the challenge of quality management.

UNIT IV DESIGN 9

Process Design, Emotional Design – Three levels of Design – Viceral, Behavioral and Reflective – Recycling and availability – Creativity and customer needs analysis – Innovative product and service designs, future directions in this application of creativity thinking in quality management.

UNIT V INNOVATION 10

Achieving Creativity – Introduction to TRIZ methodology of Inventive Problem Solving the essential factors – Innovator's solution – creating and sustaining successful growth – Disruptive Innovation model – Segmentive Models – New market disruption – Commoditation and De-commoditation – Managing the Strategy Development Process – The Role of Senior Executive in Leading New Growth – Passing the Baton.

Total : 45 Periods

REFERENCES

1. *Floyd Hurr, **"Rousing Creativity: Think New Now"**, Crisp Publications Inc. (1999)*
2. *Geoffrey Petty, **"How to be better at Creativity"**, The Industrial Society (1999)*
3. *Donald A. Norman, **"Emotional Design"**, Perseus Books Group New York , (2004)*
4. *Clayton M. Christensen , Michael E. Raynor, **"The Innovator's Solution"**, Harvard Business School Press Boston, USA, (2003)*
5. *Semyon D. Savransky, **"Engineering of Creativity – TRIZ"**, CRC Press New York USA, (2000)*

12ED1H	ADVANCED MACHINE TOOL DESIGN	L	T	P	C
		3	0	0	3

Aim

To equip the students for designing machine tools in advanced level

Objective

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

- Understand various forces created during cutting and its consequences
- Explain the design procedures for various parts of machine tools
- Describe the methods of designing of slide ways
- Familiarize about the designing of various drives and spindles
- Study the technologies behind the design of cutting tools

UNIT I STATIC AND DYNAMIC STIFFNESS, FORCE ANALYSIS 9

Static stiffness and compliance – deformation caused by weight, Forces – deformation caused by cutting forces – forced vibrations, self-excited vibrations, Force distribution in different parts of Lathe, Drilling machine, Milling machine.

UNIT II DESIGN OF STRUCTURES 9

Beds, columns and housing for maximum strength and rigidity – cast and welded construction – CNC machine tools – structure – main drive and feed drive – ball screws – automatic tool changers – chip conveyors – tool magazines – tool turrets.

UNIT III DESIGN OF SLIDE WAYS 9

Selection of materials – integrated and attached ways – hydro-static guide ways, aero-static guide ways – antifriction guide ways – design of friction guide ways – plastic inserted guide ways and LM guide ways.

UNIT IV DESIGN OF MACHINE TOOL SPINDLES AND DRIVES 9

Design requirements – standards – selection of spindle bearings – materials for spindles – typical spindle design – design consideration of Electrical, Mechanical and Hydraulic drives in machine tools.

UNIT V MACHINE TOOL CHATTER 9

Dynamics of cutting process – physical causes of chatter – theory of machine tool chatter – chatter in different types of machine tools – milling machines, lathes and grinding machines – the theory of chatter with several degree of freedom – chatter suppression. Design of control mechanisms – selection of standard components – dynamic measurement of forces and vibrations in machine tools – use of vibration dampers.

Total : 45 Periods

REFERENCES

1. *Mehta, N.K. "**Machine Tool Design**" Tata McGraw Hill, (1989)*
2. *Koenisberger, F., "**Design principles of Metal cutting Machine Tools**", Pergamon press, (1964)*
3. *Acherkan, N., "**Machine Tool Design**", Vol. 3 & 4, MIR Publishers, Moscow, (1968)*
4. *Sen, G. and Bhattacharya, A., "**Principles of Machine Tools**". Vol. 2 NCB. Calcutta, (1973)*
5. *Tobias, S.A., "**Machine Tool Vibration**" Blackie and Son Limited, London, (1965)*

12ED1I	ENTERPRISE RESOURCE PLANNING	L	T	P	C
		3	0	0	3

Aim

To understand the role of ERP in the production system.

Objective

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

- Understand the value chain and supply chain models
- Define the architecture of ERP.
- Know the ERP system packages
- Define the various modules of ERP
- Understand the ERP issues.

UNIT I ENTERPRISE RESOURCE PLANNING 10

Principle – ERP framework – Business Blue Print – Business Engineering vs. Business process Re-Engineering – Tools – Languages – Value chain – Supply and Demand chain – Extended supply chain management – Dynamic Models –Process Models.

UNIT II TECHNOLOGY AND ARCHITECTURE 10

Client/Server architecture – Technology choices – Internet direction – Evaluation framework – CRM – CRM pricing – chain safety – Evaluation framework.

UNIT III ERP SYSTEM PACKAGES 10

SAP, People soft, Baan and Oracle – Comparison – Integration of different ERP applications – ERP as sales force automation – Integration of ERP and Internet – ERP Implementation strategies – Organizational and social issues.

UNIT IV MODULES OF ERP 7

Overview – Architecture – AIM – applications – Oracle SCM – SAP: Overview Architecture – applications – Before and after Y2K – critical issues – Training on various modules of IBCS ERP Package – Oracle ERP and MAXIMO, including ERP on the NET.

UNIT V ERP PROCUREMENT ISSUES 8

Market Trends – Outsourcing ERP – Economics – Hidden COST Issues –ROI – Analysis of cases from five Indian Companies.

Total : 45 periods

REFERENCES

1. *Sadagopan, S., **"ERP-A Managerial Perspective"**, Tata Mcgraw Hill, (1999)*
2. *Jose Antonio Fernandez , **"The SAP R/3 Handbook"**, Tata Mcgraw Hill, (1998)*
3. *Vinod Kumar Crag and N.K.Venkitakrishnan , **"Enterprise Resource Planning – Concepts and Practice"**, Prentice Hall of India, (1998)*
4. *Garg & Venkitakrishnan, **"ERPWARE , ERP Implementation Framework"**, Prentice Hall, (1999)*
5. *Thomas E. Vollmann and Bery Whybark, **"Manufacturing and Control Systems"**, Galgothia Publications, (1998)*

12ED2A	ENGINEERING FRACTURE MECHANICS	L	T	P	C
		3	0	0	3

Aim

To Understand the fundamentals of fracture mechanics and to study the fatigue crack initiation, growth and applications of fracture mechanics.

Objective

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

- Define the near field equations to determine the stress-strain and load-displacement fields around a crack tip for linear elastic cases.
- Identify and formulate the stress intensity factor ((K) for typical crack configurations
- Identify and formulate J-integral and the stress and strain fields around a crack tip for different types of materials
- Define empirical relation describing crack growth law.
- Predict the fatigue life of structures using fracture mechanics approaches.

UNIT I ELEMENTS OF SOLID MECHANICS 9

The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation – limit analysis – Airy's function – field equation for stress intensity factor.

UNIT II STATIONARY CRACK UNDER STATIC LOADING 9

Two dimensional elastic fields – Analytical solutions yielding near a crack front – Irwin's approximation – plastic zone size – Dugdaale model – determination of J integral and its relation to crack opening displacement.

UNIT III ENERGY BALANCE AND CRACK GROWTH 9

Griffith analysis – stable and unstable crack growth – Dynamic energy balance – crack arrest mechanism – K1c test methods – R curves – determination of collapse load.

UNIT IV FATIGUE CRACK GROWTH CURVE 9

Empirical relation describing crack growth law – life calculations for a given load amplitude – effects of changing the load spectrum – rain flow method – external factors affecting the K1c values – leak before break analysis.

UNIT V APPLICATIONS OF FRACTURE MECHANICS 9

Crack Initiation under large scale yielding – thickness as a design parameter – mixed mode fractures – crack instability in thermal and residual stress fields – numerical methods.

Total : 45 Periods

REFERENCES

1. *David Broek,* ***"Elementary Engineering Fracture Mechanics*** *", Fifthoff and Noerdhoff International Publisher, (1978)*
2. *Kare Hellan,* ***"Introduction of Fracture Mechanics"****, McGraw-Hill Book Company, (1985)*
3. *Preshant Kumar,* ***"Elements of Fracture Mechanics****", Wheeler Publishing, (1999)*
4. *John M.Barson and Stanely T.Rolfe ,* ***"Fatigue and fracture control in structures"****, Prentice hall Inc. Englewood cliffs, (1977)*
5. *David Broek,* ***"Elementary Engineering Fracture Mechanics",*** *4th edition, Kluwer Academic Publishers, (1982)*

12ED2B	COMPOSITE MATERIALS AND MECHANICS	L	T	P	C
		3	0	0	3

Aim

To understand the fundamentals of composite material and different types of analysis of Laminated flat plate composites.

Objective

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

- Understand the fundamentals of composite material strength and its mechanical behavior.
- Use the fiber reinforced Laminate design for different Combinations of plies with different orientations of the fiber.
- Study the thermo-mechanical behavior and study of residual stresses in Laminates during processing.
- Understand the vibration and buckling analysis of Laminated Flat Plates.
- Implement the Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronic chips.

UNIT I LAMINA CONSTITUTIVE RELATIONS 10

Definition – Need – General Characteristics, Applications – Fibers – Glass, Carbon, Ceramic and Aramid fibers – Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint – Generalized Hooke's Law – Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Q_{ij}), Typical Commercial material properties, Rule of Mixtures – Generally Orthotropic Lamina – Transformation Matrix, Transformed Stiffness – Manufacturing: Bag Moulding – Compression Moulding – Pultrusion – Filament Winding – Other Manufacturing Processes.

UNIT II FLAT PLATE LAMINATE CONSTITUTIVE RELATIONS 10

Definition of stress and Moment Resultants – Strain Displacement relations – Basic Assumptions of Laminated anisotropic plates – Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates – Laminate Structural Moduli – Evaluation of Lamina Properties from Laminate Tests – Quasi-Isotropic Laminates – Determination of Lamina stresses within Laminates.

UNIT III LAMINA STRENGTH ANALYSIS 7

Introduction – Maximum Stress and Strain Criteria – Von-Misses Yield criterion for Isotropic Materials – Generalized Hill's Criterion for Anisotropic materials – Tsai-Hill's Failure Criterion for Composites – Tensor Polynomial (Tsai-Wu) Failure criterion – Prediction of laminate Failure.

UNIT IV ANALYSIS OF LAMINATED FLAT PLATES 10

Equilibrium Equations of Motion – Energy Formulations – Static Bending Analysis – Buckling Analysis – Free Vibrations – Natural Frequencies.

UNIT V EFFECT OF THERMAL PROPERTIES 8

Modification of Hooke's Law due to thermal properties – Modification of Laminate Constitutive Equations – Orthotropic Lamina – special Laminate Configurations – Unidirectional, Off-axis, Symmetric Balanced Laminates – Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates.

Total : 45 Periods

REFERENCES

12ED2C DESIGN OF PRESSURE VESSELS AND PIPING

L	T	P	C
3	0	0	3

Aim

To understand the basic concepts of Design of Pressure vessels and pipings.

Objectives

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

- Understand the various terminology for design of pressure vessels and pipings.
- Know the Stresses in pressure vessels basic concepts.
- Familiarize the design of pressure vessels processes.
- Explain the buckling and fracture analysis in vessels
- To provide in depth study of pipings basic principles

UNIT I INTRODUCTION 5

Methods for determining stresses – Terminology and Ligament Efficiency – Applications.

UNIT II STRESSES IN PRESSURE VESSELS 12

Introduction – Stresses in a circular ring, cylinder – Membrane stress Analysis of Vessel Shell components – Cylindrical shells, spherical Heads, conical heads – Thermal Stresses – Discontinuity stresses in pressure vessels.

UNIT III DESIGN OF VESSELS 12

Design of Tall cylindrical self supporting process columns – supports for short vertical vessels – stress concentration at a variable Thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings – Theory of Reinforcement – pressure vessel Design.

UNIT IV BUCKLING AND FRACTURE ANALYSIS IN VESSELS 9

Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

UNIT V PIPING 7

Introduction – Flow diagram – piping layout and piping stress Analysis.

Total : 45 Periods

REFERENCES

1. *John F. Harvey,* ***"Theory and Design of Pressure Vessels"****, CBS Publishers and Distributors, (1987)*
2. *Henry H. Bedner,* ***"Pressure Vessels, Design Hand Book"****, CBS publishers and Distributors, (1987)*
3. *Stanley, M. Wales,* ***"Chemical process equipment, selection and Design"****, Buterworths series in Chemical Engineering, (1988)*
4. *William. J., Bees,* ***"Approximate Methods in the Design and Analysis of Pressure Vessels and Piping"****, Pre ASME Pressure Vessels and Piping Conference, (1997)*
5. *Phillip Ellenberger,* ***"Pressure Vessels: ASME code simplified",*** *McGraw Hill Professional, (2004)*

12ED2D MAINTENANCE ENGINEERING

L	T	P	C
3	0	0	3

Aim

To understand the basic concepts of Maintenance Concepts and its application.

Objectives

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

- Understand the various Maintenance System.
- Know the condition based Maintenance concepts
- Familiarize the Maintenance Techniques Such As Reliability Centered Maintenance (Rcm),Total Productive maintenance(Tpm) & Cmms.
- To provide in depth study of Asset Planning AndScheduling Of Activities In Maintenance.
- Describe the different types of Safety And Other Aspects Of Maintenance Functions

UNIT I INTRODUCTION TO MAINTENANCE SYSTEMS 8

Introduction to repair and Maintenance – Maintenance as business – Maintenance systems such as reactive, preventive, predictive or proactive systems – Human resources management in Maintenance management – maintainability – Inherent and overall availability – Mean time between failures, mean time to repairs and mean down time – Testability and supportability – Design for Maintenance – Poor maintainability aspects – Design for reliability.

UNIT II CONDITION BASED MAINTENANCE 7

Condition based monitoring of equipment and systems – condition monitoring techniques: Vibration analysis, Ultrasonic detection techniques, Thermography, Oil and lubricant analysis and Motor condition monitoring (MCM) – Shaft alignments through laser – Vibration instruments – Outline on Thermography.

UNIT III MAINTENANCE TECHNIQUES SUCH AS RELIABILITY CENTRED MAINTENANCE (RCM),TOTAL PRODUCTIVE AINTENANCE(TPM) & CMMS 10

Reliability centred Maintenance – Failure Mode and Effect Analysis – Root cause Analysis – logic tree analysis – Criticality matrix – Total Productive Maintenance, Overall Equipment Effectiveness – Lean manufacturing – TPM and TPO – Relationship between OEE and world class Maintenance – Ladder of Maintenance improvement – Computerized Maintenance management system in a business scenario – data acquisition for effective management of CMMS.

UNIT IV ASSET PLANNING AND SCHEDULING OF ACTIVITIES IN MAINTENANCE 10

Asset and spare part management – Conventional spare Parts management techniques such as Economic Order Quantity, two bin systems – Latest trends in monitoring through bar codes, mobile computer and wireless data transmissions – Different aspects of planning and scheduling of Maintenance, such as shutdown – Critical aspects of both routine and shut down Maintenance – bar charts – PERT network during shut down – Man power Training and utilization of skilled manpower – Sequencing of activities.

UNIT V SAFETY AND OTHER ASPECTS OF MAINTENANCE FUNCTIONS 10

Safety Engineering – Hazard analysis – General rules and guidelines in safety and hazard prevention – Analytical tools – Hazard analysis – Fault Tree Analysis – Sneak Circuit analysis – Integrated approach to Maintenance – Statistical distributions such as normal, gamma and "Weibull" in Maintenance – Maintenance effectiveness.

Total : 45 Periods

REFERENCES

1. *Venkataraman, K., **"Maintenance Engineering and Management",** PHI Learning, (2007)*
2. *Kelly. A and Harris, M. J, **"Management of Industrial maintenance"**, Butter worth & Co., (1978)*
3. *David J. Smith, **"Reliability and Maintainability in Perspective"**, McMillan, 2nd Edition, (1985).*
4. *Gwidon, W. Stachowiak and Andrew W. Batchelor, "**Engineering Tribology"**, Butterwork-Heinmann, (2001)*
5. *Keith Mobley, **"Maintenance Engineering Handbook",** McGraw Hill Professional, (2008)*

12ED2E MICRO ELECTRO MECHANICAL SYSTEMS

L	T	P	C
3	0	0	3

Aim

To study the micro electro mechanical systems and its applications.

Objective

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

- Understand the various techniques involved in micro electro mechanical systems.
- Learn the different types of electro mechanical sensors.
- Study the mechanical finite element tools techniques.
- Study the various types of pressure sensors used in MEMS.
- Know application of force. Torque and inertial sensors in MEMS

UNIT I INTRODUCTION 8

Introduction, Materials-substrates, Additive materials. Fabrication techniques – Deposition, Lithography, etching, Surface micro machining, Thick film screen-printing and electroplating.

UNIT II MECHANICAL SENSOR PACKAGING 8

Introduction, Standard IC packages – ceramic, plastic and metal packages – Packaging process – Electrical interconnects, Methods of die attachment, sealing techniques – MEMS mechanical sensor packaging.

UNIT III MECHANICAL TRANSDUCTION TECHNIQUES 9

Piezo resistivity, Piezoelectricity, Capacitive Techniques, Optical techniques, Resonant techniques – Actuation techniques, Smart Sensors – MEMS Simulation and Design tools – Behavioral model ling simulation tools and Finite element simulation tools.

UNIT IV PRESSURE SENSORS 12

Introduction – Techniques for sensing – Physics of pressure sensing – Pressure sensor specifications – Dynamic pressure sensing – Pressure sensor types – MEMS technology pressure sensors – Micro machined silicon diaphragms.

UNIT V FORCE, TORQUE AND INERTIAL SENSORS 8

Introduction – Silicon based devises – Optical devises – capacitive devises – Magnetic devices – Atomic force microscope and scanning probes – micro machined accelerometer – Micro machined Gyroscope – Future inertial micro machined sensors.

Total : 45 Periods

REFERENCES

1. *Nadim Maluf and Kirt Williams,* ***"An Introduction to Micro electro mechanical System Engineering"****, Artech House , Inc., Boston (2003)*
2. *Stephen Beeby, Graham Ensell, Michael Kraft and Neil White,* ***"MEMS Mechanical sensors"*** *Artech House , Inc., Boston (2003)*
3. *Nicolae Lobontiu,* ***"Dynamics of Microelectromechanical Systems",*** *Springer, (2007)*
4. *KI Bang Lee,* ***"Principles of Microelectromechanical systems",*** *John Wiley publication, (2011)*
5. *Vijay K. Varadan, Vinoy, K.J., Gopalakrishnan, S.,* ***"Smart materials systems and MEMS: Design and Development Methodology",*** *John Wiley publications, (2006)*

12ED2F	PLASTICITY AND METAL FORMING	L	T	P	C
		3	0	0	3

Aim

To study the theory of plasticity and metal forming processes.

Objective

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

- Study the stress strain relation between the various metals.
- Understand the relationship between mechanical properties.
- Know the evolution technique of metal forming process.
- Analysis the numerical solutions and simulation technique of metal forming process.
- Study the advancing process of metal forming process.

UNIT I THEORY OF PLASTICITY 9

Theory of plastic deformation – Engineering stress and strain relationship – Stress tensor – Strain tensor – Yield criteria's – Plastic stress strain relationship – Plastic work – Equilibrium conditions – Incremental plastic strain.

UNIT II CONSTITUTIVE RELATIONSHIPS AND INSTABILITY 7

Uniaxial tension test – Mechanical properties – Work hardening, Compression test, bulge test, plane strain compression stress, plastic instability in uniaxial tension stress, plastic instability in biaxial tension stress.

UNIT III ANALYSIS OF METAL FORMING PROBLEMS 12

Slab analysis – Slip line method, upper bound solutions, statistically admissible stress field, numerical methods, contact problems, effect of friction, thermo elastic, elasto plasticity, elasto visco plasticity – Thermo mechanical coupling – Analysis of forging, rolling, extrusion and wire drawing processes – Experimental techniques of the evaluation of metal forming.

UNIT IV ANALYSIS OF SHEET METAL FORMING 8

Bending theory – Cold rolling theory – Hill's anisotropic theory, Hill's general yield theory – Sheet metal forming – Elements used – Mesh generation and formulation Equilibrium equations – Consistent full set algorithm – Numerical solutions procedures – examples of simulation of simple parts – Bench mark tests – Forming limit diagrams.

UNIT V ADVANCES IN METAL FORMING **9**

Orbital forging, Isothermal forging, Warm forging, Hot and Cold isotropic pressing, high speed extrusion, rubber pad forming, micro blanking – Superplastic forming – Overview of Powder Metal techniques – Powder rolling – Tooling and process parameters.

Total : 45 Periods

REFERENCES

1. *Wagoner, R H., Chenot. J.J.,* ***"Metal Forming analysis",*** *Cambridge University Press, (2002)*
2. *Slater, R.A.C.,* ***"Engineering Plasticity – Theory & Applications to Metal Forming",*** *John Wiely and Sons, (1987)*
3. *Shiro Kobayashi, Altan, T,* ***"Metal Forming and Finite Element Method",*** *Oxford University Press, (1989)*
4. *Narayanaswamy, R.,* ***"Theory of Metal Forming Plasticity",*** *Narosa Publishers, (1999)*
5. *Hosford. W. F and Caddell. RM.,* ***"Metal Forming Mechanics and Metallurgy",*** *Prentice Hall Eaglewood Cliffs, (1993)*

12ED2G	MODAL ANALYSIS OF MECHANICAL SYSTEMS	L	T	P	C
		3	0	0	3

Aim

To study about the various modes of vibrations of mechanical systems

Objective

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

- Understand the modal testing methods and philosophies
- Explain about the theoretical background of SDOF and MDOF systems
- Describe the various measurement systems involved in modal analysis
- Know the extractin methods of various modal parameters like peak amplitude etc.,
- Familiarize the mathematical models based on modal analysis

UNIT I OVERVIEW 8

Introduction to Modal Testing – Applications of Modal Testing – Philosophy of Modal Testing – Summary of Theory – Summary of Measurement Methods – Summary of Analysis – Review of Test Procedure.

UNIT II THEORETICAL BASIS 10

Introduction – Single Degree of Freedom (SDOF) System Theory – Presentation and Properties of FRF Data for SDOP System – Undamped Multi-degree of freedom (MDOF) system – Proportional Damping – Hysteretic Damping – General Case – Viscous Damping – General Case – Characteristics and presentation of MDOF – FRF Data – Complete and incomplete models - Non-sinusoidal vibration and FRF Properties – Analysis of Weakly Nonlinear Structures.

UNIT III MOBILITY MEASUREMENT TECHNIQUES 10

Introduction – Basic Measurement System – Structure preparation – Excitation of the Structure – Transducers and Amplifiers – Analyzers – Digital Signal Processing – Use of Different Excitation types – Calibration – Mass Cancellation – Rotational Mobility Measurement – Measurement on Non linear structures – Multi point excitation methods.

UNIT IV MODAL PARAMETER EXTRACTION METHODS 10

Introduction – Preliminary checks of FRF Data – SDOF Modal Analysis-I – Peak-amplitude – SDOF Modal Analysis-II – Circle Fit Method – SDOF Modal Analysis III – Inverse Method – Residuals – MDOF curve-fitting procedures – MDOF curve fitting in the Time Domain – Global or Multi-Curve fitting – Non linear systems.

UNIT V DERIVATION OF MATHEMATICAL MODELS 7

Introduction – Modal Models – Display of Modal Model – Response Models – Spatial Models – Mobility Skeletons and System Models.

Total : 45 Periods

REFERENCES

1. *Ewins D J,* ***"Modal Testing: Theory and Practice "****, John Wiley & Sons Inc., (1988)*
2. *Nuno Manuel Mendes Maia et al,* ***"Theoretical and Experimental Modal Analysis",*** *Wiley John & sons, (1997)*
3. *He & Fu,* ***"Modal Analysis",*** *Butterworth-Heinemann, Jordan Hill, (2001)*
4. *Giuseppe Conciauro, Marco Guglielmi, Roberto Sorrentino,* ***"Advanced modal analysis: CAD techniques for waveguide components and filters",*** *Volume:1", John Wiley, (2000)*
5. *Zu-Qing Qu,* ***"Modal order Reduction Techniques with applications in Finite Element Analysis",*** *Springer, (2004)*

12ED2H	DESIGN OF HEAT EXCHANGERS	L	T	P	C
		3	0	0	3

Aim

To understand the design of heat exchanger, condenser and cooling tower.

Objectives

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

- Understand the basic concepts of heat exchanger and classifications.
- Analyze the effect of turbulence and thermal stresses for pressure vessels
- Study about heat transfer and pressure loss and simulation of heat exchangers
- Know the compact and plate heat exchangers
- Understand the cooling tower and performance characteristics

UNIT I FUNDAMENTALS OF HEAT EXCHANGER 9

Temperature distribution and its implications types – shell and tube heat exchangers – regenerators and recuperators – analysis of heat exchangers – LMTD and effectiveness method.

UNIT II FLOW AND STRESS ANALYSIS 9

Effect of turbulence – friction factor – pressure loss – stress in tubes – header sheets and pressure vessels – thermal stresses, shear stresses, types of failures.

UNIT III DESIGN ASPECTS 9

Heat transfer and pressure loss – flow configuration – effect of baffles – effect of deviations from ideality – design of double pipe, finned tube, shell and tube heat exchangers, simulation of heat exchangers.

UNIT IV COMPACT AND PLATE HEAT EXCHANGERS 9

Types – merits and demerits – design of compact heat exchangers, plate heat exchangers – performance influencing parameters, limitations.

UNIT V CONDENSERS & COOLING TOWERS 9

Design of surface and evaporative condensers – cooling tower – performance characteristics.

Total : 45 Periods

REFERENCES

1. *Arthur, P., Frass,* ***"Heat Exchanger Design"****, John Wiley & Sons, (1988)*
2. *Taborek.T, Hewitt.G.F and Afgan.N,* ***"Heat Exchangers, Theory and Practice"****, McGraw-Hill Book Co., (1980)*
3. *Hewitt.G.F, Shires.G.L, Bott.T.R,* ***"Process Heat Transfer"****, CRC Press, (1994)*
4. *Sadik Kakac, Hongtan Liu,* ***"Heat Exchangers Selection, Rating and Thermal Design"****, CRC Press, (2002)*
5. *Eric M. Smith,* ***"Thermal design of heat exchangers: a numerical approach – direct sizing and stepwise rating",*** *John Wiley, (1997)*

12ED2I PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING

L	T	P	C
3	0	0	3

Aim

To study the various factors that enhances the productivity management and the applications of re-engineering concept.

Objectives

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

- Know the role productivity concepts
- Understand the systems approach to productivity measurement
- Study the organizational transformation models
- Discuss the reengineering tools
- Understand the re-engineering process improvement models

UNIT I PRODUCTIVITY 9

Productivity Concepts – Macro and Micro factors of productivity – Dynamics of Productivity – Productivity Cycle Productivity Measurement at International, National and Organization level – Productivity measurement models.

UNIT II SYSTEMS APPROACH TO PRODUCTIVITY MEASUREMENT 9

Conceptual frame work, Management by Objectives (MBO), Performance Objectivated Productivity (POP) – Methodology and application to manufacturing and service sector.

UNIT III ORGANISATIONAL TRANSFORMATION 9

Elements of Organisational Transformation and Reengineering – Principles of organizational transformation and re-engineering, fundamentals of process re-engineering, preparing the workforce for transformation and re-engineering, methodology, guidelines, LMI CIP Model – DSMC Q & PMP model.

UNIT IV RE-ENGINEERING TOOLS AND IMPLEMENTATION 9

PMI models, PASIM Model, Moen and Nolan Strategy for process improvement, LMICIP Model, NPRDC Model.

UNIT V RE-ENGINEERING PROCESS IMPROVEMENT MODELS 9

Analytical and process tools and techniques – Information and Communication Technology – Implementation of Reengineering Projects – Success Factors and common implementation Problem – Cases.

Total : 45 Periods

REFERENCES

1. *Sumanth, D.J., **"Productivity Engineering and Management"**, TMH, New Delhi, (1990)*
2. *Edosomwan, J.A., **"Organisational Transformation and Process Re-engineering"**, Library Cataloging in Pub. Data, (1996)*
3. *Rastogi, P.N., "Re-**engineering and Re-inventing the Enterprise"**, Wheeler Pub. New Delhi, (1995)*
4. *Premvrat, Sardana, G.D. and Sahay, B.S., "**Productivity Management – A Systems Approach"**, Narosa Publishing House. New Delhi, (1998)*
5. *Donald Shandler, **"Reengineering the training function: How to align training with the new corporate agenda",** St.Lucie press, (1996)*

12ED3A	QUALITY CONCEPTS IN DESIGN	L	T	P	C
		3	0	0	3

Aim

To study all the concepts coming under the quality for designing purpose

Objective

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

- Study about the QFD and house of quality
- Know about the advancements of FMEA
- Familiarize the product testing methods in DOE
- Describe the statistical consideration of quality concepts
- Study the details about SIX SIGMA

UNIT I DESIGN FOR QUALITY 9

Quality Function Deployment – House of Quality – Objectives and functions – Targets – Stakeholders – Measures and Matrices – Design of Experiments – design process – Identification of control factors, noise factors, and performance metrics – developing the experimental plan – experimental design –testing noise factors – Running the experiments – Conducting the analysis – Selecting and conforming factor – Set points – reflecting and repeating.

UNIT II FAILURE MODE EFFECT ANALYSIS 9

Basic methods: Refining geometry and layout, general process of product embodiment – Embodiment checklist – Advanced methods: systems modeling, mechanical embodiment principles – FMEA method – linking fault states to systems modeling – Case study – computer monitor stand for a docking station

UNIT III DESIGN OF EXPERIMENTS 9

Design of experiments – Basic methods – Two factorial experiments – Extended method – reduced tests and fractional experiments, orthogonality, base design method, higher dimensional fractional factorial design – Statistical analysis of experiments: Degree of freedom, correlation coefficient, standard error of the residual t-test, ANOVA – ratio test, other indicators – residual plots, Advanced DOE method for product testing – Product applications of physical modeling and DOE, Blender panel display evaluation, coffee grinder experimental optimization – Taguchi method.

UNIT IV STATISTICAL CONSIDERATION AND RELIABILITY 9

Frequency distributions and Histograms – Run charts – stem and leaf plots – Pareto diagrams – Cause and Effect diagrams – Box plots- Probability distribution – Statistical Process control – Scatter diagrams – Multivariable charts – Matrix plots and 3-D plots – Reliability – Survival and Failure – Series and parallel systems – Mean time between failure – Weibull distribution.

UNIT V DESIGN FOR SIX SIGMA 9

Basis of SIX SIGMA – Project selection for SIX SIGMA – SIX SIGMA problem solving – SIX SIGMA in service and small organizations – SIX SIGMA and lean production – Lean SIX SIGMA and services.

Total : 45 periods

REFERENCES

1. *Kevin Otto & Kristin Wood,* ***"Product Design Techniques in Reverse Engineering and New Product Development"****, Pearson Education (LPE), (2001)*
2. *Karl t. Ulrich, steven d. Eppinger,* ***"Product Design And Development"****, Tata McGraw Hill, 3rd Edition, (2003)*
3. *James R. Evens, William M Lindsay,* ***"The Management and control of Quality",*** *6th edition-Pub:son south-western, (2011)*
4. *Amitava Mitra,* ***"Fundamentals of Quality control and improvement"****, 2nd edition, Pearson Education Asia, (2002)*
5. *Dhillon, B.S.,* ***"Advanced Design Concepts for Engineers",*** *Technomic Publication company, USA, (1998)*

12ED3B	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3

Aim

To understand the Computational Fluid Dynamics in engineering problems.

Objectives

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

- Solve the two and three dimensional steady state problems
- Understanding the governing differential equation and finite difference method
- Know the computation of boundary layer flow, finite difference approach.
- Study about incompressible flow, convection heat transfer and FEM
- Understand the turbulence models

UNIT I GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD 10

Classification, Initial and Boundary conditions – Initial and Boundary Value problems – Finite difference method, Central, Forward, Backward difference, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT II CONDUCTION HEAT TRANSFER 10

Steady one-dimensional conduction, Two and three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems.

UNIT III INCOMPRESSIBLE FLUID FLOW 10

Governing Equations, Stream Function – Verticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, finite difference approach.

UNIT IV CONVECTION HEAT TRANSFER AND FEM 10

Steady One-Dimensional and Two-Dimensional Convection – diffusion, Unsteady one-dimensional convection – diffusion, Unsteady two-dimensional convection – Diffusion – Introduction to finite element method – solution of steady heat conduction by FEM – Incompressible flow – simulation by FEM.

UNIT V TURBULENCE MODELS 5

Algebraic Models – One equation model, K – R Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

Total :45 periods

REFERENCES

1. *Muralidhar, K., and Sundararajan, T.,* ***"Computational Fluid Flow and Heat Transfer"****, Narosa Publishing House, New Delhi, (1995)*
2. *Ghoshdasdidar, P.S.,* ***"Computer Simulation of flow and heat transfer"****, Tata McGraw-Hill Publishing Company Ltd., (1998)*
3. *Subas, V.Patankar* ***"Numerical heat transfer fluid flow"****, Hemisphere Publishing Corporation, (1980)*
4. *Taylor, C and Hughes, J.B.* ***"Finite Element Programming of the Navier-Stokes Equation"****, Pineridge Press Limited, U.K., (1981)*
5. *Anderson, D.A., Tannehill, J.I., and Pletcher, R.H.,* ***"Computational fluid Mechanics and Heat Transfer"****, Hemisphere Publishing Corporation, New York, USA, (1984)*

12ED3C	INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS	L	T	P	C
		3	0	0	3

Aim

To know the robot kinematics, control of various drives and programming concepts

Objectives

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

- Understand the kinematics and dynamics of robot control systems
- Know various drives and gripper functions
- Describe the principles and the functions of sensors and robot vision system
- Knows the work cell layouts and safety systems followed in the industrial applications
- Design the program for robot motion and the problems obtained are solved and reduced by artificial intelligence and expert systems

UNIT I INTRODUCTION AND ROBOT KINEMATICS 10

Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors – Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

UNIT II ROBOT DRIVES AND CONTROL 9

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

UNIT III ROBOT SENSORS 9

Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation – Image Grabbing – Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing – Image segmentation – Pattern recognition – Training of vision system.

UNIT IV ROBOT CELL DESIGN AND APPLICATION 9

Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis – Industrial application of robots.

UNIT V ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS 8

Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation – Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques – Application of AI and KBES in Robots.

Total : 45 periods

REFERENCES

1. *Fu, K.S., R.C. Gonzalez and C.S.G. Lee,* ***"Robotics Control, Sensing, Vision and Intelligence"****, Mc Graw Hill, (1987)*
2. *Yoram Koren,* ***"Robotics for Engineers",*** *Mc Graw-Hill, (1987)*
3. *Richard. D, Klafter, Thomas, A, Chmielewski, Michael Negin,* ***"Robotics Engineering – An Integrated Approach"****, Prentice-Hall of India Pvt. Ltd., (1984)*
4. *Deb, S.R.,* ***"Robotics Technology and Flexible Automation"****, Tata Mc Graw-Hill, (1994)*
5. *Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey,* ***"Industrial Robotics Technology, Programming and Applications"****, Mc Graw-Hill, Int. (1986)*

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12ED3D	DESIGN OF MATERIAL HANDLING EQUIPMENTS	L	T	P	C
		3	0	0	3

(Use of Approved Data book is permitted for the end semester examination)

Aim:

To study about the design concepts of various material handling equipments

Objective

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

- Study the types of materials and selection of materials
- Know the designing procedures for various hoists
- Familiarize the drives used in hoisting techniques
- Designing the various types of conveyors
- Designing the different types of elevators and fork lifts

UNIT I MATERIALS HANDLING EQUIPMENT 5

Types, selection and applications.

UNIT II DESIGN OF HOISTS 10

Design of hoisting elements: Welded and roller chains – Hemp and wire ropes – Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments – Design of forged hooks and eye hooks – crane grabs – lifting magnets – Grabbing attachments – Design of arresting gear – Brakes: shoe, band and cone types.

UNIT III DRIVES OF HOISTING GEAR 10

Hand and power drives – Traveling gear – Rail traveling mechanism – cantilever and monorail cranes – slewing, jib and luffing gear – cogwheel drive – selecting the motor ratings.

UNIT IV CONVEYORS 10

Types – description – design and applications of Belt conveyors, apron conveyors and escalators Pneumatic conveyors, Screw conveyors and vibratory conveyors.

UNIT V ELEVATORS 10

Bucket elevators: design – loading and bucket arrangements – Cage elevators – shaft way, guides, counter weights, hoisting machine, safety devices – Design of fork lift trucks.

Total : 45 Periods

REFERENCES

1. *Rudenko, N., **"Materials handling equipment"**, ELnvee Publishers, (1970)*
2. *Spivakovsy, A.O. and Dyachkov, V.K., **"Conveying Machines"**, Volumes I and II, MIR Publishers, (1985)*
3. *Alexandrov, M., **"Materials Handling Equipments"**, MIR Publishers, (1981)*
4. *Boltzharol, A., **"Materials Handling Handbook"**, The Ronald Press Company, (1958)*
5. *Lingaiah. K. and Narayana Iyengar, **"Machine Design Data Hand Book"**, Vol. 1 & 2, Suma Publishers,Bangalore, (1983)*

12ED3E	SUPPLY CHAIN MANAGEMENT	L	T	P	C
		3	0	0	3

Aim

To provide an overview of the current scenario of Supply Chain Management

Objectives

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

- Understand the role of supply chain management
- Know the various processes involved in SCM
- Study the supply chain models
- Discuss the SCM design frame work
- Understand the role of IT in SCM
-

UNIT I INTRODUCTION 5

Logistics – concepts, definitions, approaches, factors affecting logistics – Supply chain – basic tasks of the supply chain – the new corporate model.

UNIT II SUPPLY CHAIN MANAGEMENT 10

The new paradigm, the modular company, the network relations, supply process, procurement process – Distribution management.

UNIT III EVOLUTION OF SUPPLY CHAIN MODELS 10

Strategy and structure – factors of supply chain – Manufacturing strategy stages, supply chain progress – model for competing through supply chain management – PLC grid, supply chain redesign – Linking supply chain with customer.

UNIT IV SUPPLY CHAIN ACTIVITY SYSTEMS 10

Structuring the SC, SC and new products, functional roles in SC, SC design framework, collaborative product commerce (CPC).

UNIT V SCM ORGANISATIONA ND INFORMATION SYSTEM 10

The management task, logistics organization, the logistics information systems – topology of SC application – MRP, ERP, Warehouse management system, product data management – cases.

Total : 45 periods

REFERENCES

1. *Scharj, P.B., Lasen, T.S.,* ***"Managing the global supply chain"****, Viva Books, New Delhi, (2000)*
2. *Ayers, J.B.,* ***"Hand book of Supply Chain Management"****, The St. Lencie press, (2000)*
3. *Nicolas, J.N.,* ***"Competitive manufacturing management- continuous improvement, Lean production, customer focused quality"****, McGraw-Hill, NY, (1998)*
4. *Steudel, H.J. and Desruelle, P.,* ***"Manufacturing in the nintees- How to become a mean, lean and world class competitor"****, Van Nostrand Reinhold, NY, (1992)*
5. *John T. Mentzer,* ***"Supply Chain Management",*** *Sage Publications, California, (2001)*

12ED3F	RAPID PROTOTYPING AND TOOLING	L	T	P	C
		3	0	0	3

Aim

To help local enterprises enhance their global competitiveness by creating values for their discerning customers

Objective

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

1. Familiarize the model making steps involved in product design
2. Understand the various prototyping systems and its working principles
3. Learn the applications and limitations of the prototyping systems.
4. Know the geometric modeling technique and its application in reverse engineering.
5. Study the rapid tooling technique used in various field of engineering.

UNIT I INTRODUCTION 7

Need – Development of RP systems – RP process chain – Impact of Rapid Prototyping and Tooling on Product Development – Benefits – Applications – Digital prototyping – Virtual prototyping.

UNIT II LIQUID BASED AND SOLID BASED RAPID PROTOTYPING SYSTEMS 10

Stereolithography Apparatus, Fused deposition Modeling, Laminated object manufacturing, Three dimensional printing: Working Principles, details of processes, products, materials, advantages, limitations and applications – Case studies.

UNIT III POWDER BASED RAPID PROTOTYPING SYSTEMS 10

Selective Laser Sintering, Direct Metal Laser Sintering, Three Dimensional Printing, Laser Engineered Net Shaping, Selective Laser Melting, Electron Beam Melting: Processes, materials, products, advantages, applications and limitations – Case Studies.

UNIT IV REVERSE ENGINEERING AND CAD MODELING 10

Basic concept – Digitization techniques – Model Reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data Requirements – geometric modeling techniques: Wire frame, surface and solid modeling – data formats – Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation.

UNIT V RAPID TOOLING 8

Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect – Fabrication processes, Applications. Case studies – automotive, aerospace and electronic industries.

Total :45 periods

REFERENCES

1. *Chua C.K., Leong K.F., and Lim C.S.,* ***"Rapid prototyping: Principles and applications"****, 2nd edition, World Scientific Publishers, (2003)*
2. *Peter D.Hilton, Hilton/Jacobs, Paul F.Jacobs,* ***"Rapid Tooling: Technologies and Industrial Applications"****, CRC press, (2000)*
3. *Andreas Gebhardt,* ***"Rapid prototyping"****, Hanser Gardener Publications, (2003)*
4. *Liou W.Liou, Frank W.Liou,* ***"Rapid Prototyping and Engineering applications : A tool box for prototype development"****, CRC Press, (2007)*
5. *Ali K. Kamrani, Emad Abouel Nasr,* ***"Rapid Prototyping: Theory and practice"****, Springer, (2006)*

12ED3G	INTEGRATED MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

Aim

To acquire the basic knowledge and understanding of the scientific base of mechatronics that will enable the students to practice as professional mechatronic engineers.

Objective

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

- Learn the concepts of computer integrated manufacturing and management system.
- Understand the concept of group technology and computer aided process planning.
- Learn the fundamentals of computer assisted numerical control programming and programming languages.
- Understand the guidelines and criteria for implementing CAD/CAM Systems for inspection and testing of components.
- Discuss concept of Artificial Intelligence and Expert system in CIM.

UNIT I INTRODUCTION 6

Objectives of a manufacturing system-identifying business opportunities and problems classification production systems-linking manufacturing strategy and systems analysis of manufacturing operations.

UNIT II GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING 8

Introduction – part families – parts classification and cooling – group technology machine cells – benefits of group technology – Process planning function CAPP – Computer generated time standards.

UNIT III COMPUTER AIDED PLANNING AND CONTROL 10

Production Planning and Control – cost planning and control – inventory management – Material requirements planning (MRP) – shop floor control – Factory data collection system – Automatic identification system – barcode technology – automated data collection system.

UNIT IV COMPUTER MONITORING 10

Types of production monitoring systems – structure model of manufacturing process – process control & strategies – direct digital control – supervisory computer control – computer in QC – contact inspection methods non-contact inspection method – computer-aided testing – integration of CAQC with CAD/CAM.

UNIT V INTEGRATED MANUFACTURING SYSTEM 11

Definition – application – features – types of manufacturing systems – machine tools – materials handling system – computer control system – DNC systems manufacturing cell – Flexible manufacturing systems (FMS) – FMS concept – transfer systems – head changing FMS – variable mission manufacturing system – CAD/CAM system – human labour in the manufacturing system – computer integrated manufacturing system benefits – Rapid prototyping – Artificial Intelligence and Expert system in CIM.

Total : 45 periods

REFERENCES

1. *David Bedworth, **"Computer Integrated Design and Manufacturing"**, TMH, New Delhi, (1998)*
2. *Yorem Koren, "**Computer Integrated Manufacturing Systems"**, McGraw Hill, (1983)*
3. *Ranky, Paul G., "**Computer Integrated Manufacturing"**, Prentice Hall International (1986)*
4. *Yeomamas,R.W., A. Choudry and P.J.W. Ten Hagen, **"Design rules for a CIM system"**, North Holland Amsterdam, (1985)*
5. *Groover, M.P., **"Automation, Production System and CIM"**, Prentice-Hall of India, (1998)*

12ED3H	MECHATRONICS IN MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

Aim

To understand the state-of-art technology and products in Mechatronics and Robotics , take up challenging assignment in future to create professional environment.

Objective

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

- Learn to know about the basic mechatronics systems.
- Understand the modern mechatronics components.
- Understand the concept of actuators.
- Understand the concept of PLC.
- Learn to evaluate appropriate technology and create devise realistic industrial systems.

UNIT I INTRODUCTION 7

Introduction to Mechatronics – Systems – Need for Mechatronics – Emerging area of Mechatronics – Classification of Mechatronics – Measurement Systems – Control Systems.

UNIT II SENSORS AND TRANSDUCERS 10

Introduction – Performance Terminology – Potentiometer – LVDT – Capacitance – sensors – Strain gauges – Eddy current sensor – Hall effect sensor – Temperature sensors – Light sensors – Selection of sensors – Signal processing.

UNIT III ACTUATORS 10

Actuators – Mechanical – Electrical – Fluid Power – Piezoelectric – Magnetostrictive – Shape memory alloy – applications – selection actuators.

UNIT IV PROGRAMMABLE LOGIC CONTROLLERS 9

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

UNIT V DESIGN AND MECHATRONICS CASE STUDIES 9

Designing – Possible design solutions – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Conveyor based material handling system – PC based CNC drilling machine – Engine Management system – Automatic car park barrier – Data acquisition Case studies.

Total : 45 periods

REFERENCES

1. *Devadas Shetty and Richard A. Kolk, "**Mechatronics System Design"**, PWS Publishing Company, (2007)*
2. *Godfrey C. Onwubolu, **"Mechatronics Principles and Applications"**, Elsevier (2006)*
3. *Nitaigour, Premchand Malhalik, **"Mechatronic Principles, Concepts, Applications**, Tata McGraw-Hill Publishing company Limited, (2003)*
4. *Michael B.Histand and Davis G.Alciatore, **"Introduction to Mechatronics and Measurement systems"**. McGraw Hill International edition, (1999)*
5. *Bradley D.A, Dawson.D, Buru N.C and Loader A.J, **"Mechatronics"** Nelson Thornes ltd, Eswar press, Indian print, (2004)*

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12ED3I	REVERSE ENGINEERING	L	T	P	C
		3	0	0	3

Aim

To understand the fundamentals of reverse engineering, tools for reverse engineering used in factory environment.

Objective:

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

- Understand basics of reverse engineering.
- Understand the Tools and concepts used in reverse engineering.
- Learn the software tools used in data management.
- Learn to integrate reverse engineering for real time applications.
- Understand the coordinate measurement, feature capturing in reverse engineering.

UNIT I INTRODUCTION 7

Scope of tasks of R.E. – Domain Analysis – Process of Duplicating.

UNIT II TOOLS FOR RE 8

Functionality- dimensional- developing technical data - digitizing techniques - construction of surface model - solid-part material- characteristics evaluation –software and application- prototyping – verification

UNIT III CONCEPTS 10

History of Reverse Engineering – Preserving and preparation for the four stage process – Evaluation and Verification – Technical Data Generation, Data Verification, Project Implementation.

UNIT IV DATA MANAGEMENT 10

Data reverse engineering – Three data Reverse engineering strategies – Definition – organization data issues – Software application – Finding reusable software components – Recycling real-time embedded software – Design experiments to evaluate a Reverse Engineering tool – Rule based detection for reverse Engineering user interfaces – Reverse Engineering of assembly programs: A model based approach and its logical basics.

UNIT V INTEGRATION 10

Cognitive approach to program understated – Integrating formal and structured methods in reverse engineering – Integrating reverse engineering, reuse and specification tool environments to reverse engineering – coordinate measurement – feature capturing – surface and solid member.

Total : 45 periods

REFERENCES

1. *Biggerstaff,T.J.,* ***"Design Recovery for Maintenance and Reuse"****, IEEE Corpn. (1991)*
2. *Rugaban, S.,* ***"White paper on RE"****, Technical Report, Georgia Instt. of Technology, (1994)*
3. *Katheryn, A. Ingle,* ***"Reverse Engineering"****, McGraw-Hill, (1994)*
4. *Aiken, Peter,* ***"Data Reverse Engineering"****, McGraw-Hill, (1996)*
5. *Linda Wills, Kluiver* ***"Reverse Engineering"****, Academic Publishers, (1996)*

12ME6G	UNCONVENTIONAL MACHINING PROCESSES	L	T	P	C
		3	0	0	3

OBJECTIVE

To learn about various unconventional machining processes, the various process parameters and their influence on performance and their applications.

UNIT I MECHANICAL ENERGY BASED PROCESSES 9

Unconventional machining Process – Need – classification – Brief overview Abrasive Jet Machining – Water Jet Machining – Abrasive Water Jet Machining – Ultrasonic Machining (AJM, WJM, AWJM and USM) – Working Principles – equipment used – Process parameters – MRR – Variation in techniques used – Applications.

ELECTRICAL ENERGY BASED PROCESSES

UNIT II 9

Electric Discharge Machining (EDM) – working Principle – equipments – Process Parameters – Surface Finish and MRR – electrode / Tool – Power and control Circuits – Tool Wear – Dielectric – Flushing – Wire cut EDM – Applications

UNIT III CHEMICAL ENERGY BASED PROCESSES 9

Chemical machining and Electro-Chemical machining (CHM and ECM) – Etchants – maskant – techniques of applying maskants – Process Parameters – Surface finish and MRR - Applications.

UNIT IV ELECTRO-CHEMICAL ENERGY BASED PROCESSES 9

Principles of ECM – equipments – Surface Roughness and MRR – Electrical circuit – Process Parameters – ECG and ECH – Applications.

UNIT V THERMAL ENERGY BASED PROCESSES 9

Laser Beam machining and drilling (LBM), plasma Arc machining (PAM) and Electron Beam Machining (EBM) – Principles – Equipment –Types – Beam control techniques – Applications.

Total : 45 Periods

TEXT BOOKS

1. *Vijay.K. Jain,* ***"Advanced Machining Processes",*** *Allied Publishers Pvt. Ltd., New Delhi, (2010)*
2. *Mishra P.K.,* ***"Non Conventional Machining",*** *The Institution of Engineers – India, (2009)*

REFERENCES

1. *Benedict. G.F.* ***"Nontraditional Manufacturing Processes",*** *Marcel Dekker Inc., New York, (2008)*
2. *Pandey P.C. and Shan H.S.* ***"Modern Machining Processes",*** *Tata McGraw-Hill, New Delhi (2011)*
3. *Mc Geough,* ***"Advanced Methods of Machining",*** *Chapman and Hall, London (2011).*
4. *Paul De Garmo, J.T.Black and Ronald.A.Kohser,* ***"Material and Processes in Manufacturing",*** *Prentice Hall of India Pvt. Ltd., New Delhi, 8th Edition, (2010)*