St. PETER'S UNIVERSITY

St. Peter's Institute of Higher Education and Research
(Declared under section 3 of UGC Act 1956)
Avadi, Chennai – 600 054.

M.E. (ENGINEERING DESIGN) PROGRAMME

(I TO IV SEMESTERS)

REGULATIONS AND SYLLABI

(REGULATIONS – 2012)

(Effective from the Academic Year 2012-'13)

M.E. (ENGINEERING DESIGN) PROGRAMME

Regulations and Syllabi

(Effective from the Academic Year 2012-'13)

1. **Eligibility:** Candidates who passed B.E. / B.Tech. (Mechanical / Automobile / Production / Manufacturing / Industrial Engineering / Mechatronics Engineering) of the University or any other equivalent examination thereto are eligible for admission to Two Year M.E. (Engineering Design) Programme.

2. **Duration:** Two Years Comprising 4 Semesters. Each semester has a minimum 90 working days with a minimum of 5 hours a day.

3. **Medium:** English is the medium of instruction and examination.

4. **Weightage for Internal and End Assessment:** The weightage for Internal Assessment (IA) and End Assessment (EA) be 25:75 unless the ratio is specifically mentioned in the scheme of Examinations.

5. **Credit System:** Credit system be followed with 18 credits for each semester and each credit is equivalent to 25-30 hours of effective study provided in the Time Table.

6. **Scheme of Examinations (for I to IV Semesters)**

I Semester

Code No.	Course Title	Credit	Marks		
Theory			**IA**	**EA**	**Total**
112EDPT01	Applied Mathematics for Engineering Design	2	25	75	100
112EDPT02	Concepts of Engineering Design	3	25	75	100
112EDPT03	Computer Applications in Design	2	25	75	100
112EDPT04	Quality Concepts in Design	3	25	75	100
Electives					
112EDPT05	**Elective I:** Tribology in Design	3	25	75	100
112EDPT06	**Elective II:** Composite Materials and Mechanics	3	25	75	100
Practical					
112EDPP01	CAD Lab	2	25	75	100
	Total	**18**	**175**	**525**	**700**

II Semester

Code No.	Course Title	Credit	Marks		
Theory			**IA**	**EA**	**Total**
212EDPT01	Finite Elements Methods in Mechanical Design	2	25	75	100
212EDPT02	Vibration Analysis and Control	2	25	75	100
212EDPT03	Mechanism Design And Simulation	3	25	75	100
212EDPT04	Mechanical Behavior of Materials	3	25	75	100
Electives					
212EDPT05	**Elective III :** Productivity Management and Re- Engineering	3	25	75	100
212EDPT06	**Elective IV :** Industrial Robotics and Expert system	3	25	75	100
Practical					
212EDPP01	Analysis and Simulation Lab	1	25	75	100
212EDPP02	Seminar	1	25	75	100
	Total	**18**	**200**	**600**	**800**

III Semester

Code No.	Course Title	Credit	Marks		
Theory			**IA**	**EA**	**Total**
312EDPE03	**Elective V:** Design Of Hydraulics And pneumatics	3	25	75	100
312EDPE16	**Elective VI :** Integrated Manufacturing System	3	25	75	100
312EDPE19	**Elective VII :** Mechatronics	3	25	75	100
Project					
312EDPP01	Project Work Phase -I	9	50	150	200
	Total	**18**	**125**	**375**	**500**

IV Semester

Code No.	Course Title	Credit	Marks		
Project			**IA**	**EA**	**Total**
412EDPP01	Project Work Phase -II	18	100	300	400
	Total	**18**	**100**	**300**	**400**

LIST OF ELECTIVES

COURSE CODE	ELECTIVES
	I Semester
112EDPE01	Optimization Techniques in Design
112EDPE02	Engineering Fracture Mechanics
112EDPE03	**Tribology in Design**
112EDPE04	Advanced Mechanics of Materials
112EDPE05	**Composite Materials and Mechanics**
112EDPE06	Applied Engineering Acoustics
	II Semester
212EDPE01	Advanced Tool Design
212EDPE02	**Productivity Management and Re-Engineering**
212EDPE03	**Industrial Robotics and Expert Systems**
212EDPE04	Design Materials Handling Equipments
212EDPE05	Plasticity and Metal Forming
212EDPE06	Plates and Shells
	III Semester
312EDPE01	Design of Pressure Vessel and Piping
312EDPE02	Modal Analysis of Mechanical Systems
312EDPE03	**Design of Hydraulic and Pneumatic System**
312EDPE04	Experimental Stress Analysis
312EDPE05	Maintenance Engineering
312EDPE06	Bearing Design and Rotor Dynamics
312EDPE07	Mini Project
312EDPE08	Design Paradigm
312EDPE09	Micro Electro Mechanical System
312EDPE10	Creativity in Design
312EDPE11	Reverse Engineering
312EDPE12	Enterprise Resource Planning
312EDPE13	Supply Chain Management
312EDPE14	Computational Fluid Dynamics
312EDPE15	Design For Manufacture Assembly & Environment
312EDPE16	**Integrated Manufacturing Design**
312EDPE17	Design of Heat Exchangers
312EDPE18	Rapid Prototyping and Tooling
312EDPE19	**Mechatronics in Manufacturing Systems**

7. **Passing Requirements:** The minimum pass mark (raw score) be 50% in End Assessment (EA) and 50% in Internal Assessment (IA) and End Assessment (EA) put together. No minimum mark (raw score) in Internal Assessment (IA) be prescribed unless it is specifically mentioned in the Scheme of Examination.

8. Grading System: Grading System on a 10 Point Scale be followed with 1 mark = 0.1 Grade point to successful candidates as given below.

CONVERSION TABLE

(1 mark = 0.1 Grade Point on a 10 Point Scale)

Range of Marks	Grade Point	Letter Grade	Classification
90 to 100	9.0 to 10.0	O	First Class
80 to 89	8.0 to 8.9	A	First Class
70 to 79	7.0 to 7.9	B	First Class
60 to 69	6.0 to 6.9	C	First Class
50 to 59	5.0 to 5.9	D	Second Class
0 to 49	0 to 4.9	**F**	**Reappearance**

Procedure for Calculation

Cumulative Grade Point Average (CGPA) = $\frac{\text{Sum of Weighted Grade Points}}{\text{Total Credits}}$

$= \frac{\sum (CA+EA)\, C}{\sum C}$

Where Weighted Grade Points in each Course = Grade Points (CA+EA) multiplied by Credits

$= (CA+EA)C$

Weighted Cumulative Percentage of Marks(WCPM) = CGPAx10

C- Credit, CA-Continuous Assessment, EA- End Assessment

9. Pattern of the Question Paper: The question paper for End Assessment will be set for three hours and for the maximum of 100 marks with following divisions and details.

Part A: 10 questions (with equal distribution to all units in the syllabus). Each question carries 2 marks.

Part B: 5 questions with either or type (with equal distribution to all units in the syllabus). Each question carries 16 marks.

The total marks scored by the candidates will be reduced to the maximum prescribed in the Regulations.

10. Effective Period of Operation for the Arrear Candidates : Two Year grace period is provided for the candidates to complete the arrear examination, if any.

Registrar

11. Syllabus

I SEMESTER

112EDPT01 – APPLIED MATHEMATICS

Unit I CALCULAUS OF VARIATION

Introduction – Euler's equation – several dependent variables Lagrange's equation of Dynamics – Integrals involving derivatives higher that the first – problem with constrains – Direct methods and eigen value problems.

Unit II MATRIX THEORY

Eigen values using QR transformations – generalized eigenvectors – canonical forms – singular value decomposition and applications - pseudo inverse – least square approximations.

Unit III LINEAR PROGRAMMING PROBLEM

Graphical method – simplex method - Big M Technique – Integer programming.

Unit IV ONE DIMENSIONAL WAVE AND HEAT EQUATION

Laplace Transform methods for one – dimensional Wave equation – Displacements in a line string – Longitudinal vibration of an elastic bar - Fourier Transform methods for one dimensional Heat conduction problems in infinite and semi infinite rods.

UNIT V ELLIPTIC EQUATION

Laplace equation – Properties of harmonic functions – Solution of Laplace's equation by means of Fourier transforms in a half plane, in an infinite strip and in a semi-infinite strip – Solution of Poisson equation by Fourier transform method.

REFERENCES:

1. Gupta, A.S., Calculus of Variations with Applications, Prentice – Hall of India New Delhi, 1997.
2. Broson, R., Matrix operations, Schaum's outline series, McGraw Hill, New York, 1989.
3. Taha H.A., "Operation Research-An Introduction", Prentice Hall of India, 2001.
4. Sankara Rao,K., Introduction to Partial Differential Equations, Prentice – Hall of India, New Delhi, 1995.

112EDPT02 - CONCEPTS OF ENGINEERING DESIGN

1. DESIGN FUNDAMENTALS

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.

2. CUSTOMER ORIENTED DESIGN & SOCIETAL CONSIDERATIONS

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.

3. DESIGN METHODS

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.

4. MATERIALS SELECTION PROCESSING AND DESIGN

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.

5. PROBABILITY CONCEPTS IN DESIGN FOR RELIABILITY

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

TEXT BOOKS:

Dieter, George E., "Engineering Design – A Materials and Processing Approach", McGraw Hill, International Editions, Singapore, 2000.

REFERENCES:

1. Pahl, G, and Beitz, W., "Engineering Design", Springer – Verlag, NY. 1984.
2. Ray, M.S., "Elements of Engg. Design", Prentice Hall Inc. 1985.
3. Suh, N.P., "The principles of Design", Oxford University Press, NY. 1990.
Karl T. Ulrich and Steven D. Eppinger "Product Design and Development" McGraw Hill Edition 2000.

112EDPT03 - COMPUTER APPLICATIONS IN DESIGN

1. INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS

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.

2. INTRODUCTION TO CAD SOFTWARE

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).

3. SOLID MODELING

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.

4. VISUAL REALISM

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.

5. ASSEMBLY OF PARTS

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

REFERENCES:

1. William M Neumann and Robert F.Sproul "Principles of Computer Graphics", Mc Graw Hill Book Co., Singapore, 1989.

2. Donald Hearn and M. Pauline Baker "Computer Graphics", Prentice Hall, Inc., 1992.

3. Ibrahim Zeid Mastering CAD/CAM – McGraw Hill, International Edition, 2007.

4. Foley, Wan Dam, Feiner and Hughes – Computer graphics principles & practices, Pearson Education – 2003.

5. Donald Heam and M. Pauline Baker "Computer Graphics", Prentice Hall, Inc., 1992.

112EDPT04 - QUALITIY CONCEPTS IN DESIGN

AIM

To study about robust design, embodiment principles, various methods in design of experiments, reliability charts and histograms and six sigma techniques.

1. DESIGN FOR QUALITY

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.

2. FAILURE MODE EFFECT ANALYSIS

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.

3. DESIGN OF EXPERIMENTS

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.

4. 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.

5. DESIGN FOR SIX SIGMA

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.

REFERENCE:

1. Product Design Techniques in Reverse Engineering and New Product Development, KEVIN OTTO & KRISTIN WOOD, Pearson Education (LPE), 2001.
2. Product Design And Development, KARL T. ULRICH, STEVEN D. EPPINGER, TATA McGRAW – HILL -3 rd Edison, 2003.
3. The Management and control of Quality-6th edition-James R. Evens, William M Lindsay Pub:son south-western(www.swlearning.com)
4. Fundamentals of Quality control and improvement 2nd edition, AMITAVA MITRA, Pearson Education Asia, 2002.

112EDPP01 - CAD LAB

- **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.

  Exercises in Modeling and drafting of Mechanical Components – Assembly using Parametric and feature based Packages like PRO-E / SOLID WORKS / CATIA / NX etc.

II SEMESTER

212EDPT01 - FINITE ELEMENT METHODS IN MECHANICAL DESIGN

OBJECTIVE:

At the end of this course the students would have developed a through understanding of the basic principles of the finite element analysis techniques with an ability to effectively use the tools of the analysis for solving practical problems arising in engineering design.

UNIT-I: GENERAL INTRODUCTION*

Introduction – structural element and system – assembly and analysis of a structure – boundary conditions – general pattern – standards 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 – numerical examples.

UNIT-II: GENERALIZATION OF FINITE ELEMENT CONCEPTS AND ELEMENT SHAPE FUNCTIONS*

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 – transformation in ξ, η and ζ – coordinates – order of convergence – numerical integration – example problems.

UNIT-III: APPLICATIONS TO FIELD PROBLEMS*

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**

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 – example problems.

UNIT-V: NON-LINEAR ANALYSIS***

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 – modeling considerations.

NOTE

At the post-graduate level of instruction the contact hours are to be supplemented by self study by students. As for the examination, modeling considerations, choice of elements, boundary conditions, loading conditions, and basic procedures only need to be emphasized without expecting a complete numerical solution to practical problems.

REFERENCES

1. *Zienkiewicz.O.C, Taylor.R.L,& Zhu,J.Z "The Finite Element Method: Its Basis & Fundamentals", Butterworth-Heinemann (An imprint of Elsevier), First printer in India 2007, India Reprint ISBN:978-81-312-1118-2, published by Elsevier India Pvt. Ltd., New Delhi.

2. **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, First Reprint 2007, Authorized reprint by Wiley India(P) Ltd., New Delhi, ISBN-13 978-81-265-1336-9

3. ***Zienkiewicz.O.C, Taylor.R.L "The Finite Element Method" McGraw Hill International Editions, Fourth Edition, 1991, Volume 2 (Chapters 7&8)

4. Reddy, J.N., "Introduction to Non-Linear Finite Element Analysis", Oxford University Press, 2008

5. Rao,S.S., "The Finite Element Method in Engineering", Butterworth-Heinemann (An imprint of Elsevier), reprinted 2006, 2007, Published by Elsevier India Pvt. Ltd., New Delhi, Indian Reprint ISBN:978-81-8147-885-6

6. Huebner,K.H., Dewhirst,D.L., Smith,D.E & Byron, T.G., "The Finite Element Method for Engineers", Wiley Student Edition, Fourth Edition 2004, John Wiley&Sons(Asia)Pvt. Ltd., ISBN: 9812-53-154-8

7. Ramamurthi, V., "Finite Element Method in Machine Design", Narosa Publishing House, January 2009, ISBN:978-81-7319-965-3

212EDPT02 - VIBRATION ANALYSIS AND CONTROL**

OBJECTIVE:

(i) To understand the Fundamentals of Vibration and its practical applications.
(ii) To understand the working principle and operations of various vibrations Measuring instruments
(iii) To understand the various Vibration control strategies

1. FUNDAMENTALS OF VIBRATION

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 Excitations – Transient Vibration- Impulse loads – Critical Speed Of Shaft – Rotor systems.

2. TWO DEGREE FREEDOM SYSTEM

Introduction – Free Vibration Of Undamped And Damped – Forced Vibration With Harmonic Excitation System – Coordinate Couplings And Principal Coordinates.

3. MULTI-DEGREE FREEDOM SYSTEM AND CONTINUOUS SYSTEM

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 Systems: Vibration of String, Shafts and Beams.

4. VIBRATION CONTROL

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

5. EXPERIMENTAL METHODS IN VIBRATION ANALYSIS

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

****a Term Project must be given for Assessment – 3 (Compulsory)**

TEXT BOOK:

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.

REFERENCES:

1. Ramamurti. V, "Mechanical Vibration Practice with Basic Theory", Narosa, New Delhi, 2000.
2. S. Graham Kelly & Shashidar K. Kudari, "Mechanical Vibrations", Tata McGraw-Hill Publishing Com. Ltd., New Delhi, 2007.

212EDPT03 - MECHANISMS DESIGN AND SIMULATION**

1. INTRODUCTION
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.

2. KINEMATIC ANALYSIS
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.

3. PATH CURVATURE THEORY, COUPLER CURVE
Fixed and moving centrodes, inflection points and inflection circle. Euler Savary equation, graphical constructions – cubic of stationary curvature. Four bar coupler curve–cusp-crunode-coupler driven six-bar mechanisms – straight line mechanisms.

4. SYNTHESIS OF FOUR BAR MECHANISMS
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.

5. SYNTHESIS OF COUPLER CURVE BASED MECHANISMS & CAM MECHANISMS
Cognate Lingages – 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.
Study and use of Mechanism using Simulation Soft-ware packages.
Students should design and fabricate a mechanism model as term project.

****a Term Project must be given for Assessment – 3 (Compulsory)**

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 Malik, "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.
6. Ramamurthi, V., "Mechanics of Machines", Narosa, 2005.

212EDPT04 - MECHANICAL BEHAVIOR OF MATERIALS

1. BASIC CONCEPTS OF MATERIAL BEHAVIOR

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 behavior – Super plasticity – Griffith's theory – Ductile, brittle transition in steel – High temperature fracture, creep – Larson Miller parameter – Deformation and fracture mechanism maps.

2. BEHAVIOUR UNDER DYNAMIC LOADS AND DESIGN APPROACHES

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 of non metallic materials – Failure analysis, sources of failure, procedure of failure analysis.

3. SELECTION OF MATERIALS

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.

4. MODERN METALLIC MATERIALS

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.

5. NON METALLIC MATERIALS

Polymeric materials – Formation of polymer structure – Production techniques of fibers, forms, adhesives and coating – structure, properties and applications of engineering polymers – Advanced structural ceramics WC, TIC, TaC, Al_2O_3, SiC, Si_3N_4 CBN and diamond – properties, processing and applications.

REFERENCES:

1. George E.Dieter, Mechanical Metallurgy, McGraw Hill, 1988.
2. Thomas H. Courtney, Mechanical Behaviour 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, (34d 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.
6. Ashby M.F., materials selection in Mechanical Design 2nd Edition, Butter worth 1999.
7. www.astm.org/labs/pages/131350.htm.

212EDPP01 - ANALYSIS AND SIMULATION LAB

Analysis of Mechanical Components – Use of FEA Packages like ANSYS/NASTRAN etc., Exercises shall include analsis 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, Analysis of velocity and acceleration for mechanical linkages of different mechanisms.

ELECTIVES

112EDPE01 - OPTIMIZATION TECHNIQUES IN DESIGN

1. UNCONSTRAINED OPTIMIZATION TECHNIQUES

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.

2. CONSTRAINED OPTIMIZATION TECHNIQUES

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

3. ADVANCED OPTIMIZATION TECHNIQUES

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

4. STATIC APPLICATIONS

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.

5. DYNAMIC APPLICATIONS

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

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 machne", Barnen, Addison-Wesley, New York, 1989.

112EDPE02 - ENGINEERING FRACTURE MECHANICS

1. ELEMENTS OF SOLID MECHANICS

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

2. STATIONARY CRACK UNDER STATIC LOADING

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.

3. ENERGY BALANCE AND CRACK GROWTH

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

4. FATIGUE CRACK GROWTH CURVE

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

5. APPLICATIONS OF FRACTURE MECHANICS

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

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.

112EDPE03 - TRIBOLOGY IN DESIGN

1. SURFACE INTEACTION AND FRICTION

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.

2. WEAR AND SURFACE TREATMENT

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.

3. LUBRICANTS AND LUBRICATION REGIMES

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.

4. THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION

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.

5. HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION

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.

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. S.K.Basu, S.N. Sengupta & B.B.Ahuja, "Fundamentals of Tribology", Prentice-Hall of India Pvt Ltd., New Delhi, 2005.
6. G.W.Stachwiak & A.W. Batchelor, Engineering Tribology, Butterworth-Heinemann, UK, 2005.

112EDPE04 - ADVANCED MECHANICS OF MATERIALS

1. ELASTICITY

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.

2. SHEAR CENTER AND UNSYMMETRICAL BENDING

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

3. CURVED FLEXIBLE MEMBERS AND STRESSES IN FLAT PLATES

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.

4. TORSION OF NON-CIRCULAR SECTIONS

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

5. STRESSES IN ROTARY SECTIONS AND CONTACT STRESSES

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.

REFERENCES:

1. Arthur P Boresi, Richard J. Schmidt, "Advanced mechanics of materials", John Wiley, 2002.
2. Timoshenko and Goodier, "Theory of Elasticity", McGraw Hill.
3. Robert D. Cook, Warren C. Young, "Advanced Mechanics of Materials", Mcmillan pub. Co., 1985.
4. Srinath. L.S., "Advanced Mechanics of solids", Tata McGraw Hill, 1992.
5. G H Ryder Strength of Materials Macmillan, India Ltd., 2007.

112EDPE05 - COMPOSITE MATERIALS AND MECHANICS

OBJECTIVE

i) To understand the fundamentals of composite material strength and its mechanical behavior.
ii) Understanding the analysis of fiber reinforced Laminate design for different.
iii) Combinations of plies with different orientations of the fiber.
iv) Thermo-mechanical behavior and study of residual stresses in Laminates during processing.
v) Implementation of Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronic chips.

1. LAMINA CONSTITUTIVE RELATIONS

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. Reductions to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic striffness 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.

2. FLAT PLATE LAMINATE CONSTITUTIVE RELATIONS

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.

3. LAMINA STRENGTH ANALYSIS

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. Prediction of laminate Failure.

4. ANALYSIS OF LAMINATED FLAT PLATES

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

5. EFFECT OF THERMAL PROPERTIES

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.

TEXT BOOK:

1. Gibson, R.F., Principles of Composite Material Mechanics; McGraw-Hill, 1994. Second Edition – CRC press in progress.
2. Hyer, M.W., "Stress Analysis of Fiber – Reinforced Composite Materials", McGraw-Hill, 1998.

REFERENCES:

1. Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials". Oxford University Press - 2006, First Indian Edition – 2007.
2. Malick, P.K. Fiber – "Reinforced Composites: Materials, Manufacturing and Design", Maneel Dekker Inc, 1993.
3. Halpin, J.C., "Primer on Composite Materials, Analysis", Techomic Publishing Co., 1984.
4. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 1990.
5. Malick, P.K. and Newman, S., (edition), "Composite Materials Technology: Processes and Properties", Hansen Publisher, Munish, 1990.
6. Madhujit Mukhopadhyay, "Mechanics of Composite Materials and Structures", University Press (India) Pvt. Ltd., Hyderabad, 2004 (Reprinted 2008).

112EDPE06 - APPLIED ENGINEERING ACOUSTICS

1. BASIC CONCEPTS OF ACOUSTICS

Scope of Acoustics – Sound pressure – Sound Intensity – Sound power level Sound power – Wave motion – Alteration of wave paths – Measurement of sound waves – sound spectra – Sound fields – Interference – Standing waves – Acoustic energy density and intensity – Specific acoustic impedance.

2. CHARACTERISTICS OF SOUND

One dimensional wave equation – Solution of 1 D wave equation – Velocity in gaseous medium – Velocity of plane progressive sound wave through a thin solid rod- Velocity of plane wave in a bulk of solid – Transverse wave propagation along a string stretched under tension – Wave equation in two dimension.

3. TRANSMISSION PHENOMENA

Changes in media – Transmission from one fluid medium to another, normal incidence, oblique incidence – Reflection at the surface of a solid, normal incidence, oblique incidence – Standing wave pattern – Transmission through three media.

4. INTRODUCTION TO THE ASSESSMENT AND MEASUREMENT OF SOUND

Introduction – Decibel scale for the measurement of sound power – Sound level meter – Weighted sound pressure level – Equal Loudness contours – Perceived noisiness – Loudness, Loudness level, perceived noise, perceived noise level – Equivalent sound level – Identified level – Frequency and Amplitude measurements.

5. BASICS OF NOISE CONTROL

Noise Control at source, path, receiver – Noise control by acoustical treatment – Machinery noise – Types of machinery involved – Determination of sound power and sound power level – Noise reduction procedures – Acoustic enclosures.

REFERENCES:

1. Lawrence E. Kinsler, Auarin R. Frey, "Fundamentals of Acoustics" – John Wiley and Sons Inc., 1986.

2. Bies, David, A. and Hansen, Colin H., "Engineering Noise Control – Theory and Practice", E and FN Spon, Champman-Hall, Second Edition, 1996.

3. Hansen C.H. and Snyder, S.D., "Active Control of Sound and Vibration", E and FN Spon, London 1996.

212EDPE01 - ADVANCED TOOL DESIGN

1. INTRODUCTION TO TOOL DESIGN

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.

2. DESIGN OF CUTTING TOOLS

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.

3. DESIGN OF JIGS AND FIXTURES

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.

4. DESIGN OF PRESS TOOL DIES

Types of Dies – Method of Die operation – Clearance and cutting force calculations – Blanking and Plercing 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.

5. TOOL DESIGN FOR CNC MACHINE TOOLS

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.

REFERENCES:

1. Cyrll Donaldson , George H.LeCain, V.C. Goold, "Tool Design", Tata McGraw Hill Publishing Company Ltd., 2000.
2. E.G.Hoffman, "Jig 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.

212EDPE02 – PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING

1. PRODUCTIVITY

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

2. SYSTEMS APPROACH TO PRODUCTIVITY MEASUREMENT

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

3. ORGANISATIONAL TRANSFORMATION

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.

4. RE-ENGINEERING PROCESS IMPROVEMENT MODELS

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

5. RE-ENGINEERING TOOLS AND IMPLEMENTATION

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

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.

212EDPE03 – INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS

1. INTRODUCTION AND ROBOT KINEMATICS

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.

2. ROBOT DRIVES AND CONTROL

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.

3. ROBOT SENSORS

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 systems.

4. ROBOT CELL DESIGN AND APPLICATION

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.

5. ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

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.

TEXT BOOK:

1. K.S.Fu, R.C. Gonzalez and C.S.G. Lee, "Robotics Control Sensing, Vision and Intelligence", Mc Graw Hill, 1987.

REFERENCES:

1. Yoram Koren, "Robotics for Engineers" Mc Graw-Hill, 1987.
2. Kozyrey, Yu. "Industrial Robots", MIR Publishers Moscow, 1985.
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.
6. Timothy Jordanides et al, "Expert Systems and Robotics", Springer – Verlag, New York, May 1991.

212EDPE04 – DESIGN OF MATERIAL HANDLING EQUIPMENTS
(Use of Approved Data Book Is Permitted)

1. MATERIALS HANDLING EQUIPMENT
Types, selection and applications.

2. DESIGN OF HOISTS
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.

3. DRIVES OF HOISTING GEAR
Hand and power drives – Travelling gear – Rail travelling mechanism – cantilever and monorail cranes – slewing, jib and luffing gear – cogwheel drive – selecting the motor ratings.

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

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

TEXT BOOKS

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.

REFERENCES

1. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.
2. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.
3. P.S.G. Tech., "Design Data Book" Kalaikathir Achchagam, Coimbatore, 2003.
4. Lingaiah. K. and Narayana Iyengar, "Machine Design Data Hand Book", Vol. 1 & 2, Suma Publishers, Bangalore, 1983.

212EDPE05 – PLASTICITY AND METAL FORMING

1. THEORY OF PLASTICITY

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.

2. CONSTITUTIVE RELATIONSHIPS AND INSTABILITY

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.

3. ANALYSIS OF METAL FORMING PROBLEMS

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.

4. ANALYSIS OF SHEET METAL FORMING

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 test – Forming limit diagrams.

5. ADVANCES IN METAL FORMING

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.

REFERENCES:

1. Wagoner. R.H., and 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.

6. Surender Kumar, "Technology of Metal Forming Processes", Prentice Hall of India, New Delhi, 2008.

212EDPE06 – THEORY OF PLATES & SHELLS

OBJECTIVE:
After undergoing this course, the students would be in a position to understand the behavior of these commonly occurring structural elements in engineering design and would have developed the capability to design and analyse them in their normal design practice.

1. GENERAL INTRODUCTION
Review of equations of elasticity – kinematics, compatibility equations, stress measures – equations of motions – constitutive relations – transformation of stresses, strains and stiffness – energy principles and variational methods in elasticity – virtual work – external and internal virtual work – variational operator – functional – Euler Lagrange equations – energy principles – Hamilton's principle – principle of minimum total potential – applications.

2. CLASSICAL THEORY OF PLATES
Plates as structural elements – stress and moment resultants – assumptions made in the classical theory – displacement fields and strains – equations of equilibrium in Cartesian coordinates and in polar coordinates – boundary conditions – bending of rectangular plates with various boundary conditions and loading – symmetrical and asymmetrical bending of circular plates – limitations of classical theory – finite element analysis (elementary treatment only; discussion of various elements used and their capabilities – not for examination).

3. BUCKLING ANALYSIS OF RECTANGULAR PLATES
Buckling of simply supported plates under compressive forces – governing equations – the Navier solution – biaxial compression of a plate – uniaxial compression of a plate – buckling of plates simply supported on two opposite edges – Levy's solution – buckling of plates with various boundary conditions – general formulation – finite element analysis (elementary treatment only; discussion of various elements used and their capabilities – not for examination).

4. VIBRATION OF PLATES
Governing equations for natural flexural vibrations of rectangular plates – natural vibrations of plates simply supported on all edges – vibration of plates with two parallel sides simply supported – Levy's solution – vibration of plates with different boundary conditions – Rayleigh – Ritz method – Natural vibration of plates with general boundary conditions – transient analysis of rectangular plates – finite element analysis (elementary treatment only; discussion of various elements used and their capabilities – not for examination).

5. ANALYSIS OF THIN ELASTIC SHELLS OF REVOLUTION
Classification of shell surfaces – geometric properties of shells of revolution – general strain displacement relations for shells of revolution – stress resultants – equations of motion of thin shells – analytical solution for thin cylindrical shells – membrane theory – flexure under axisymmetric loads – shells with double curvature – geometric considerations – equations of equilibrium – bending of spherical shells – vibration of cylindrical shells – finite element analysis (elementary treatment only; discussion of various elements used and their capabilities – not for examination).

REFERENCE:

1. Reddy.J.N., "Theory and Analysis of Elastic Plates & Shells", C.R.C. Press, NY, USA, 2nd Edition.
2. Szilard, R., Theory and Analysis of Plates, Prentice Hall Inc., 1995.
3. Timoshenko, S. and Krieger S.W. Theory of Plates and shells, McGraw Hill Book Company, New York 1990.
4. Wihelm Flugge, stresses in shells, Springer – Verlag.
5. Timoshenko, S, Theory of Plates and Shells, McGraw Hill, 1990.
6. Ramasamy, G.S., Design and Construction of Concrete Shells Roofs, CBS Publishers, 1986.
7. Dr.N. Subramanian, Principles of Space Structures, Wheeler Publishing Co. 1999.

312EDPE01 – DESIGN OF PRESSURE VESSELS AND PIPING

1. INTRODUCTION

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

2. STRESSES IN PRESSURE VESSELS

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.

3. DESIGN OF VESSELS

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.

4. BUCKLING AND FRACTURE ANALYSIS IN VESSELS

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.

5. PIPING

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

TEXT BOOKS

1. John F. Harvey, Theory and Design of Pressure Vessels, CBS Publishers and Distributors, 1987.

REFERENCES

1. Henry H. Bedner, "Pressure Vessels, Design Hand Book, CBS publishers and Distributors, 1987.

2. Stanley, M. Wales, "Chemical process equipment, selection and Design, Butterworths series in Chemical Engineering, 1988.

3. William. J., Bees, "Approximate Methods in the Design and Analysis of Pressure Vessels and Piping", Pre ASME Pressure Vessels and Piping Conference, 1997.

312EDPE02 – MODAL ANALYSIS OF MECHANICAL SYSTEMS

1. OVERVIEW

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.

2. THEORETICAL BASIS

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 Dampling – General Case – Characteristics and presentation of MDOF – FRF Data – Complete and incomplete models – Non-sinusoidal vibration and FRF Properties – Analysis of Weakly Nonlinear Structures.

3. MOBILITY MEASUREMENT TECHNIQUES

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.

4. MODAL PARAMETER EXTRACTION METHODS

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

5. DERIVATION OF MATHEMATICAL MODELS

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

REFERENCES:

1. Ewins D J, "Modal Testing: Theory and Practice", John Wiley & Sons Inc., 1988.
2. Nuno Manuel Mendas Mala et al, "Theoretical and Experimental Modal Analysis", Wiley John & sons, 1997.

312EDPE03 – DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS

1. OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS

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

2. CONTROL AND REGULATION ELEMENTS

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

3. HYDRAULIC CIRCUITS

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.

4. PNEUMATIC SYSTEMS AND CIRCUITS

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.

5. INSTALLATION, MAINTENANCE AND SPECIAL CIRCUITS

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

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 Punlishing House, 1999.
4. Bolton. W, "Pneumatic and Hydraulic Systems", Butterworth – Heinemann 1997.
5. K.Shanmuga Sundaram, "Hydraulic and Pneumatic Controls: Understanding made Easy" S. Chand & Co Book publishers, New Delhi, 2006 (Reprint 2009).

312EDPE04 – EXPERIMENTAL STRESS ANALYSIS

1. FORCES AND STRAIN MEASUREMENT

Strain gauge, principle, types, performance and uses, Photo elasticity – Principle and applications – Moire Fringe – Hydraulic jacks and pressure gauges – Electronic load cells – Proving Rings – Calibration of Testing Machines.

2. VIBRATION MEASUREMENTS

Characteristics of Structural Vibrations – Linear Variable Differential Transformer (LVDT) – Transducers for velocity and acceleration measurements. Vibration meter – Seismographs – Vibration Analyzer – Display and recording of signals – Cathode Ray Oscilloscope – XY Plotter – Chart Plotters – Digital data Acquisition systems.

3. ACOUSTICS AND WIND FLOW MEASURES

Principles of Pressure and flow measurements – pressure transducers – sound level meter – venturimeter and flow meters – wind tunnel and its use in structural analysis – structural modeling – direct and indirect model analysis.

4. DISTRESS MEASUREMENTS

Diagnosis of distress in structures, buildings, bridges and towers – Rebound Hammer – acoustic emission – ultrasonic testing principles and application – Holography – use of laser for structural testing – Brittle coating.

REFERENCES:

1. Sadhu Singh – Experimental Stress Analysis, Khanna Publishers, New Delhi, 1996.
2. JW Dalley and WF Riley, Experimental Stress Analysis, McGraw Hill Book Company, N.Y. 1991.
3. L.S. Srinath et al, Experimental Stress Analysis, Tata McGraw Hill Company,, New Delhi, 1984.
4. R.S. Sirohi, HC Radhakrishna, Mechanical Measurements, New Age International (P) Ltd. 1997.
5. F.K Garas, J.L. Clarke and GST Armer, Structural assessment, Butterworths, London, 1987.
6. D.E. Bray & R.K. Stanley, Non-destructive Evaluation, McGraw Hill Publishing Company, N.Y. 1989.

312EDPE05 – MAINTENANCE ENGINEERING

1. INTRODUCTION TO MAINTENANCE SYSTEMS

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.

2. CONDITION BASED MAINTENANCE

Condition based monitoring of equipment and systems – condition monitoring techniques such as a) Vibration analysis b) Ultrasonic detection techniques, c) Thermography, d) Oil and lubricant analysis, e) Motor condition monitoring (MCM) – Shaft alignments through laser – Vibration Instruments – Outline on Thermography.

3. MAINTENANCE TECHNIQUES SUCH AS RELIABILITY CENTRED MAINTENANCE (RCM), TOTAL PRODUCTIVE MAINTENANCE (TPM) & CMMS

Reliability centred Miantenance – Failure Mode and Effect Analysis – Root cause Analysis – logic tree analysis – Critically 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.

4. ASSET PLANNING AND SCHEDULING OF ACTIVITIES IN MAINTENANCE

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 shutdowns – Critical aspects of both routine and shut down – Man power Training and utilization of skilled manpower – Sequencing of activities.

5. SAFETY AND OTHER ASPECTS OF MAINTENANCE FUNCTIONS

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.

TEXT BOOK:

1. "Maintenance Engineering and Management", K.Venkataraman-PHI Learning – 2007.

REFERENCE BOOKS:

1. Kelly. A and Harris, M.J, "Management of Industrial maintenance", Butterworth & Co., 1978.

2. David J. Smith, "Reliability and Maintainability in Perspective", McMillan, 2nd Edition 1985.

3. Gwidon W Stachowiak and Andrew W. Batchelor "Engineering Tribology", Butterwork–Heinmann, 2001.

4. John V.Grimaldi & Rollin H.Simonds, "Safety Management", AITBS Publishers & Distributors, 2001.

312EDPE06 – BEARING DESIGN AND ROTOR DYNAMICS

1. CLASSIFICATION AND SELECTION OF BEARINGS

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.

2. DESIGN OF FLUID FILM BEARINGS

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.

3. SELECTION AND DESIGN OF ROLLING BEARINGS

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.

4. DYNAMICS OF HYDRODYNAMIC BEARINGS

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 conditions.

5. ROTOR DYNAMICS

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.

REFERENCES:

1. Neale, M.J. "Tribology Hand Book", Butterworth Heinemann, United Kingdom 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. S.K. Basu, S.N. Sengupta & B.B.Ahuja, "Fundamentals of Tribology", Prentice – Hall of India Pvt. Ltd., New Delhi, 2005.
6. G.W.Stachowiak & A.W. Batchelor, Engineering Tribology, Butterworth – Heinemann, UK, 2005.

312EDPE08 – DESIGN PARADIGM

OBJECTIVE

Study about the design methodologies for manufacture and assembly, value engineering techniques and analysis of product development.

1. DESIGN FOR MANUFACTURE

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.

2. FORM DESIGN OF CASTINGS AND WELDMENTS

Redesign of castings based on parting line considerations – Minimizing core requirements – Redesigning a cast members using weldments – factors influencing form design – Working principle, Material, Manufacture, Design – Possible solutions – Materials choice – Influence of materials – on from design – form design of welded members, forgings and castings.

3. DESIGN FOR ASSEMBLY

Assembly processes – Handling and insertion process – Manual, automatic and robotic assembly – Cost of Assembly – Number of Parts – DFA guidelines.

4. VALUE ENGINEERING

Value – types – functional – operational – aesthetic – cost – material – Design process – value and worthiness – procedure – brainstorming sessions – evaluation – case studies – value estimation – Value analysis – Design for value – Selection of alternatives – optimization – Implementation.

5. PRODUCT DEVELOPMENT ECONOMICS

Elements of Economics analysis – Quantitative and qualitative analysis – Economic Analysis process – Estimating magnitude and time of future cash inflows and out flows – Sensitivity analysis – Project trade-offs-Trade-offs rules – Limitation of quantitative analysis – Influence of qualitative factors on project success.

TEXT BOOK:

1. Harry Peck, Designing for Manufacture, Pitman Publications, 1983.
2. George E Dieter, Engineering Design, McGraw-Hill Int Editions, 2000.

REFERENCES:

1. S.S.Iyer, Value Engineering, New Age International, 2000.
2. Charles E. Ebeling, Reliability and Maintainability Engineering, TMH, 2000.

312EDPE09 – MICRO ELECTRO MECHANICAL SYSTEMS

1. INTRODUCTION

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

2. MECHANICAL SENSOR PACKAGING

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

3. MECHANICAL TRANSDUCTION TECHNIQUES

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.

4. PRESSURE SENSORS

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.

5. FORCE, TORQUE AND INERTIAL SENSORS

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

TEXT BOOK:

1. Nadim Maluf and Kirt Williams, An introduction to Micro electro mechanical System Engineering, Artech House, Inc. Boston. 2003.

REFERENCE:

1. Stephen Beeby, Graham Ensell, Michael Kraft and Neil White, 'MEMS Mechanical sensors' Artech House, Inc, Boston 2003.

312EDPE10 – CREATIVITY IN DESIGN

1. INTRODUCTION

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

2. MECHANISM OF THINKING AND VISUALIZATION

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 – Visualization benchmarking.

3. CREATIVITY

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.

4. DESIGN

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.

5. INNOVATION

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.

REFERENCE:

1. Rousing Creativity: Think New NewFloyd Hurr, ISBN 1560525479, 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.

312EDPE11 – REVERSE ENGINEERING

1. INTRODUCTION

Scope and tasks of RE – Domain analysis – process of duplicating.

2. TOOLS FOR RE

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

3. CONCEPTS

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

4. DATA MANAGEMENT

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.

5. INTEGRATION

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

REFERENCE:

1. Design Recovery for Maintenance and Reuse, T J Biggerstaff, IEEE Corpn. July 1991.
2. White paper on RE, S Rugaban, Technical Report. Georgia Instt. Of Technology, 1994.
3. Reverse Engineering, Katheryn, A. Ingle, McGraw-Hill, 1994.
4. Data Reverse Engineering, Aiken, Peter, McGraw-Hill, 1996.
5. Reverse Engineering, Linda Wills, Kluiver Academic Publishers, 1996.
6. Co-ordinate Measurment and reverse engineering, Donald R. Honsa, ISBN 1555897, American Gear Manufacturers Association.

312EDPE12 – ENTERPRISE RESOURCE PLANNING

1. ENTERPRISE RESOURCE PLANNING

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.

2. TECHNOLOGY AND ARCHITECTURE

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

3. ERP SYSTEM PACKAGES

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 – Organisational and social issues.
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.

4. ERP PROCUREMENT ISSUES

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

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. ERPWARE, ERP Implementation Framework, Garg & Venkitakrishnan, Prentice Hall, 1999.
5. Thomas E Vollmann and Bery Whybark, Manufacturing and Control Systems, Galgothia Publications, 1998.

312EDPE13 – SUPPLY CHAIN MANAGEMENT

1. INTRODUCTION

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

2. SUPPLY CHAIN MANAGEMENT

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

3. EVOLUTION OF SUPPLY CHAIN MODELS

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.

4. SUPPLY CHAIN ACTIVITY SYSTEMS

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

5. SCM ORGANISATION AND INFORMATION SYSTEM

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

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, ean and world class competitor, Van Nostrand Reinhold, NY, 1992.

312EDPE14 – COMPUTATIONAL FLUID DYNAMICS

1. GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD

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.

2. CONDUCTION HEAT TRANSFER

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

3. INCOMPRESSIBLE FLUID FLOW

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.

4. CONVECTION HEAT TRANSFER AND FEM

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.

5. TURBULENCE MODELS

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

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.

6. Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer – Verlag, 1987.

7. Fletcher, C.A.J. "Computational Techniques for fluid Dynamics 2" Specific Techniques for Different Flow Categories, Springer – Verlag, 1987.

8. Bose, T.X., "Numerical Fluid Dynamics" Narosa Publishing House, 1997.

312EDPE15 – DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENTS

1. INTRODUCTION

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.

2. FACTORS INFLUENCING FORM DESIGN

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

3. COMPONENT DESIGN – MACHINING CONSIDERATION

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.

4. COMPONENT DESIGN – CASTING CONSIDERATION

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.

5. DESIGN FOR THE ENVIRONMENT

Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessement – Basic method – AT&T's 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.

REFERENCES:

1. Boothroyd, G, 1980 Design for Assembly Automation and Product Design, New York, Marcel Dekker.
2. 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. Fixel, J. Design for the Environment McGraw hill, 1996.
6. Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall, Reason Pub., 1996.
7. Kevien Otto and Kristin Wood, Product Design, Pearson Publication, 2004.

312EDPE16 – INTEGRATED MANUFACTURING SYSTEMS

1. INTRODUCTION

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

2. GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING

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

3. COMPUTER AIDED PLANNING AND CONTROL

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.

4. COMPUTER MONITORING

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.

5. INTEGRATED MANUFACTURING SYSTEM

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

TEXT BOOKS:

1. Groover, M.P., "Automation, Production System and CIM", Prentice-Hall of India, 1998.

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. R.W. Yeomamas, A. Choudry and P.J.W. Ten Hagen, "Design rules for a CIM system", North Holland Amsterdam, 1985.

312EDPE17 – DESIGN OF HEAT EXCHANGERS

1. FUNDAMENTALS OF HEAT EXCHANGER

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

2. FLOW AND STRESS ANALYSIS

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

3. DESIGN ASPECTS

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.

4. COMPACT AND PLATE HEAT EXCHANGERS

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

5. CONDENSERS & COOLING TOWERS

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

REFERENCES

1. P Arthur. Frass, Heat Exchanger Design, John Wiley & Sons, 1988.
2. Tabirek. 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.

312EDPE18 – RAPID PROTOTYPING AND TOOLING

1. INTRODUCTION

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

2. LIQUID BASED AND SOLID BASED RAPID PROTOTYPING SYSTEMS

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

3. POWDER BASED RAPID PROTOTYPING SYSTEMS

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

4. REVERSE ENGINEERING AND CAD MODELING

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.

5. RAPID TOOLING

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

TEXT BOOK:

1. Rapid prototyping: Principles and applications, second edition, Chua C.K., Leong K.F., and Lim C.S., World Scientific Publishers, 2003.
2. Rapid Tooling: Technologies and Industrial Applications, Peter D.Hilton, Hilton/Jacobs, Paul F. Jacobs, CRC press, 2000.

REFERENCE:

1. Rapid prototyping, Andreas Gebhardt, Hanser Gardener Publications, 2003.
2. Rapid Prototyping and Engineering applications: A tool box for prototype development, Liou W. Liou, Frank W. Liou, CRC Press, 2007.
3. Rapid Prototyping: Theory and practice, Ali K. Kamrani, Emad Abouel Nasr, Springer, 2006.

312EDPE19 – MECHATRONICS IN MANUFACTURING SYSTEMS

OBJECTIVE

This syllabus is formed to create knowledge in Mechatronic systems and impart the source of concepts and techniques, which have recently been applied in practical situation. It gives a framework of knowledge that allows engineers and technicians to develop an interdisciplinary understanding and integrated approach to engineering.

1. INTRODUCTION

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

2. SENSORS AND TRANSDUCERS

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

3. ACTUATORS

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

4. PROGRAMMABLE LOGIC CONTROLLERS

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

5. DESIGN AND MECHATRONICS CASE STUDIES

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.

TEXT BOOK

1. Bolton. W, "Mechatronics", Pearson education, second edition, fifth Indian Reprint, 2003.

2. Smaili.A and Mrad.F, "Mechatronics Integrated technologies for intelligent machines", Oxford university press, 2008.

REFERENCES

1. Devadas Shetty and Richard A.Kolk, "Mechatronics systems design", PWS Publishing company, 2007.

2. Godfrey C. Onwubolu, "Mechatronics Principles and Applications", Elsevier, 2006.

3. Nitaigour Premchand Mahalik, "Mechatronics Principles, Concepts and 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.

6. Lawrence J.Kamm, "Understanding Electro-Mechanical Engineering – An Introduction to Mechatronics", Prentice Hall of India Pvt Ltd., 2000.

7. Dan Necsulescu, "Mechatronics", Pearson education, 2002.

8. Newton C. Braga, "Mechatronics Sourcebook", Thomson Delmar Learning, Eswar Press, 2003.

Registrar