

AFFILIATED INSTITUTIONS
ANNA UNIVERSITY : : CHENNAI 600 025
REGULATIONS - 2009
CURRICULUM I TO IV SEMESTERS (FULL TIME)
M.E. CAD / CAM

SEMESTER – I

Code No.	Course Title	L	T	P	C
THEORY					
MA 9213	Probability and Statistical Methods	3	1	0	4
CD 9211	Computer Application in Design	3	0	2	4
CC 9212	Finite Element Analysis in Manufacturing Engineering	3	0	0	3
CD 9221	Integrated Mechanical Design”	3	1	0	4
CC 9211	Competitive manufacturing systems	3	0	0	3
E1	Elective-I	3	0	0	3
PRACTICAL					
CC 9215	CAD Lab	0	0	3	3
Total		18	2	5	24

LIST OF ELECTIVES

M.E. CAD / CAM

Course Code	Course Title	L	T	P	C
CC 9250	Mechatronics in Manufacturing Systems	3	0	0	3
CC9251	Computer Aided Process Planning	3	0	0	3
CC 9252	Data Communication in CAD/CAM	3	0	0	3
CC 9253	Industrial Safety Management	3	0	0	3
CC 9254	Performance Modelling and Analysis of Manufacturing System	3	0	0	3
CI 9259	Rapid Prototyping	3	0	0	3
ED 9252	Tribology in Design	3	0	0	3
ED 9264	Design of Hydraulic and Pneumatic Systems	3	0	0	3
ED 9256	Advanced Tool Design	3	0	0	3
CC9255	Metrology and Non Destructive Testing	3	0	0	3
ED9250	Optimization Techniques in Design	3	0	0	3
ED 9223	Mechanisms Design and Simulation**	3	0	2	4
ED 9253	Advanced Mechanics of Materials	3	0	0	3
ED 9259	Design of Material Handling Equipments	3	0	0	3
IC 9262	Computational Fluid Dynamics	3	0	0	3
CC 9257	Total Quality Management	3	0	0	3
CC 9258	Reliability Engineering Models	3	0	0	3
CC 9259	Maintenance Engineering and Management	3	0	0	3
ED 9258	Industrial Robotics and Expert Systems	3	0	0	3
ED 9222	Vibration Analysis and Control**	3	0	2	4
CC 9256	Design for Cellular Manufacturing Systems	3	0	0	3

UNIT I	PROBABILITY AND RANDOM VARIABLES	12
Probability - Random variables - Moments - Moment generating function - Standard distributions - Functions of random variables - Two-dimensional R. vs. - Correlation and Regression.		
UNIT II	ESTIMATION THEORY	12
Principle of least squares - Regression - Multiple and partial correlations - Estimation of Parameters - Maximum likelihood estimates - Method of moments.		
UNIT III	TESTING OF HYPOTHESIS	12
Sampling distributions - Test based on Normal, t-distribution, Chi-square and F-distributions - Analysis of Variance - One way and Two-way classifications.		
UNIT IV	DESIGN OF EXPERIMENTS	12
Completely Randomized Design - Randomized Block design - Latin square design - 2 Factorial Design.		
UNIT V	TIME SERIES	12
Characteristics and Representation - Moving Averages - Exponential smoothing - Auto Regressive Processes.		

TOTAL: 60 PERIODS

REFERENCES:

1. Freund John, E. and Miller, Irwin, " Probability and Statistics for Engineering ", 5th Edition, Prentice Hall, 1994.
2. Jay, L. Devore, " Probability and Statistics for Engineering and Sciences", Brooks/Cole Publishing Company Monterey, California, 1982.
3. Montgomery D.C and Johnson, L.A., " Forecasting and Time Series ", McGraw-Hill.
4. Anderson, O.D., " Time Series Analysis: Theory and practice ", I. North - Holland, Amsterdam, 1982.
5. Gupta, S.C. and Kapur, V.K." Fundamentals of Mathematical Statistics ", Sultan Chand and Sons, New Delhi, 1999.

WEB REFERENCES:

1. www.maths.adelaide.edu.AU/Applied/Courses/Hps.html.
2. www.cs.cf.ac.UK/Dave/A12/nodes86.html.

UNIT I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS 11

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

UNIT II INTRODUCTION TO CAD SOFTWARE 8

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

UNIT III SOLID MODELING 8

Regularized Boolean set operations - primitive instancing - sweep representations - boundary representations - constructive solid Geometry - comparison of representations - user interface for solid modeling.

Graphics and computing standards– Open GL Data Exchange standards – IGES, STEP etc– Communication standards.

UNIT IV VISUAL REALISM 9

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

UNIT V ASSEMBLY OF PARTS 9

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

NOTE: LAB PRACTICE OF: 30 PERIODS TOTAL : 45 + 30 = 75 PERIODS

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

AIM

The aim is to provide the students with knowledge of the finite element method that will be of use in different manufacturing areas and to provide a foundation for further study.

OBJECTIVE

The objective is to equip students with fundamentals of finite element principles so as to enable them to understand the behaviour of various finite elements and to be able to select appropriate elements to solve physical and engineering problems with emphasis on structural and thermal engineering applications.

UNIT I INTRODUCTION: 6
Basics of FEM – Initial value and boundary value problems – weighted residual Galerkin and Raleigh Ritz methods – review of Variational calculus – Integration by parts – Basics of variational formulation.

UNIT II ONE DIMENSIONAL ANALYSIS: 10
Steps in FEA – Discretization, function – derivation of element characteristics matrix, shape function, assembly and imposition of boundary conditions – solution and post processing – One dimensional analysis in solid mechanics and heat transfer.

UNIT III SHAPE FUNCTIONS AND HIGHER ORDER FORMULATIONS 10
Global and Natural Co-ordinates – Shape functions for one and two dimensional elements – Three noded triangular and four noded quadrilateral element – Non linear analysis – Isoparametric elements – Jacobian matrices and transformations – Basics of two dimensional axi symmetric analysis.

UNIT IV ANALYSIS OF PRODUCTION PROCESSES 10
FE Analysis of metal casting – Special considerations, latent heat incorporation, gap element – time stepping procedures – Crank – Nicholson algorithm – Prediction of grain structure - Basic concepts of plasticity – Solid and flow formulation – small incremental deformation formulation – FE Analysis of metal cutting, chip separation criteria, incorporation of strain rate dependency.

UNIT V COMPUTER IMPLEMENTATION 9
Pre Processing, Mesh generation, elements connectivity, boundary conditions, input of material and processing characteristics – Solution and post processing – Overview of application packages such as ANSYS and DEFORM – Development of code for one dimensional analysis and validation.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Reddy, J.N, "An Introduction to the Finite element Method", McGraw – Hill, 1985.
2. Rao, "Finite Element Method in Engineering", Pergammon Press, 1989.

REFERENCES:

1. Bathe, K.J., "Finite Element Procedures in Engineering Analysis, 1990.
2. Kobayashi, S, Soo-IK-Oh and Altan, T, "Metal forming and the Finite element Methods", Oxford University Press, 1989.
3. Lewis, R.W., Morgan, K, Thomas, H.R., and Seetharaman, K.N., "The Finite Element Method in Heat Transfer Analysis", John Wiley, 1994.

UNIT I	FUNDAMENTALS AND DESIGN OF SHAFTS	15
<p>Phases of design – Standardization and interchangeability of machine elements - Process and Function Tolerances – Individual and group tolerances – Selection of fits for different design situations – Design for assembly and modular constructions – Concepts of integration – BIS, ISO, DIN, BS, ASTM Standards. Oblique stresses – Transformation Matrix – Principal stresses – Maximum shear stress - Theories of Failure – Ductile vs. brittle component design - Analysis and Design of shafts for different applications – integrated design of shaft, bearing and casing – Design for rigidity</p>		
UNIT II	DESIGN OF GEARS AND GEAR BOXES	15
<p>Principles of gear tooth action – Gear correction – Gear tooth failure modes – Stresses and loads – Component design of spur, helical, bevel and worm gears – Design for sub assembly – Integrated design of speed reducers and multi-speed gear boxes – application of software packages.</p>		
UNIT III	BRAKES	15
<p>Dynamics and thermal aspects of vehicle braking – Integrated design of brakes for machine tools, automobiles and mechanical handling equipments.</p>		
UNIT IV	INTEGRATED DESIGN	15
<p>Integrated Design of systems consisting of shaft, bearings, springs, motor, gears, belt, rope, chain, pulleys, Cam & Follower, flywheel etc. Example - Design of Elevators, Escalators, Gear Box, Valve gear Mechanisms, Machine Tools.</p>		

TOTAL: 60 PERIODS

The Pattern of Question Paper will consist one Question from Unit – 4 for 50% of total marks.

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

REFERENCES:

1. Norton L. R., "Machine Design – An Integrated Approach" Pearson Education, 2005
2. Newcomb, T.P. and Spur, R.T., "Automobile Brakes and Braking Systems", Chapman and Hall, 2nd Edition, 1975.
3. Maitra G.M., "Hand Book of Gear Design", Tata McGraw Hill, 1985.
4. Shigley, J.E., "Mechanical Engineering Design", McGraw Hill, 1986.
5. Prasad. L. V., "Machine Design", Tata McGraw Hill, New Delhi, 1992.
6. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.
7. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.

APPROVED DATA BOOKS:

1. P.S.G. Tech., "Design Data Book", Kalaikathir Achchagam, Coimbatore, 2003.
2. Lingaiah. K. and Narayana Iyengar, "Machine Design Data Hand Book", Vol. 1 & 2, Suma Publishers, Bangalore, 1983.

AIM:

To impart knowledge on the pace of changes in the manufacturing technology.

OBJECTIVE:

To emphasize the knowledge on the quality improvement, automation, and advanced manufacturing techniques to create the highest-caliber products quickly, efficiently, inexpensively, and in synchronization with the marketing, sales, and customer service of the company.

UNIT I MANUFACTURING IN A COMPETITIVE ENVIRONMENT 9

Automation of manufacturing process - Numerical control - Adaptive control - material handling and movement - Industrial robots - Sensor technology - flexible fixtures - Design for assembly, disassembly and service.

UNIT II GROUP TECHNOLOGY & FLEXIBLE MANUFACTURING SYSTEMS 9

Part families - classification and coding - Production flow analysis - Machine cell design - Benefits. Components of FMS - Application work stations - Computer control and functions - Planning, scheduling and control of FMS - Scheduling - Knowledge based scheduling - Hierarchy of computer control - Supervisory computer.

UNIT III COMPUTER SOFTWARE, SIMULATION AND DATABASE OF FMS 9

System issues - Types of software - specification and selection - Trends - Application of simulation - software - Manufacturing data systems - data flow - CAD/CAM considerations - Planning FMS database.

UNIT IV LEAN MANUFACTURING: 9

Origin of lean production system – Customer focus – Muda (waste) – Standards – 5S system – Total Productive Maintenance – standardized work – Man power reduction – Overall efficiency - Kaizen – Common layouts - Principles of JIT - Jidoka concept – Poka-Yoke (mistake proofing) - Worker Involvement– Quality circle activity – Kaizen training - Suggestion Programmes – Hoshin Planning System (systematic planning methodology) – Lean culture.

UNIT V JUST IN TIME 9

Characteristics of JIT - Pull method - quality -small lot sizes - work station loads - close supplier ties – flexible work force - line flow strategy - preventive maintenance - Kanban system - strategic implications - implementation issues - Lean manufacture.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Groover M.P., " Automation, Production Systems and Computer Integrated Manufacturing ", Third Edition, Prentice-Hall, 2007.
2. Pascal Dennis, "Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System", (Second edition), Productivity Press, New York, 2007.

REFERENCES:

1. Jha, N.K. "Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991.
2. Kalpkjian, "Manufacturing Engineering and Technology ", Addison-Wesley Publishing Co., 1995.
3. Taiichi Ohno, Toyota, " Production System Beyond Large-Scale production Productivity Press (India) Pvt.Ltd. 1992.

CC 9215

CAD LAB

L T P C
0 0 3 3

Exercises in Modeling and Analysis of Mechanical Components and assembly using Parametric and feature based Packages like PRO-E / SOLIDE WORKS /CATIA / NX / ANSYS / NASTRAN etc.

TOTAL: 45 PERIODS

EQUIPMENTS FOR CAD LAB

- | | | | |
|----|--|---|--------|
| 1. | CAD Workstations | : | 10 Nos |
| 2. | CAD, 3D Modeling Software with assembly, Mechanism simulation and drafting modules | : | 10 Nos |

ED 9250

OPTIMIZATION TECHNIQUES IN DESIGN

L T P C
3 0 0 3

UNIT I UNCONSTRAINED OPTIMIZATION TECHNIQUES 10

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

UNIT II CONSTRAINED OPTIMIZATION TECHNIQUES 10

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

UNIT III ADVANCED OPTIMIZATION TECHNIQUES 10

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

UNIT IV STATIC APPLICATIONS 8

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

UNIT V DYNAMIC APPLICATIONS 7

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

TOTAL: 45 PERIODS

REFERENCES:

1. Rao, Singaresu, S., "Engineering Optimization – Theory & Practice", New Age International (P) Limited, New Delhi, 2000.
2. Johnson Ray, C., "Optimum design of mechanical elements", Wiley, John & Sons, 1990.
3. Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India Pvt. 1995.
4. Goldberg, D.E., "Genetic algorithms in search, optimization and machine", Barmen, Addison-Wesley, New York, 1989.

ED 9252**TRIBOLOGY IN DESIGN****LT P C
3 0 0 3**

UNIT I	SURFACE INTERACTION AND FRICTION	7
Topography of Surfaces – Surface features-Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction –Rolling Friction-Friction properties of metallic and non-metallic materials – friction in extreme conditions –Thermal considerations in sliding contact		
UNIT II	WEAR AND SURFACE TREATMENT	8
Types of wear – Mechanism of various types of wear – Laws of wear –Theoretical wear models-Wear of Metals and Non metals – Surface treatments – Surface modifications – surface coatings methods- Surface Topography measurements –Laser methods – instrumentation - International standards in friction and wear measurements		
UNIT III	LUBRICANTS AND LUBRICATION REGIMES	8
Lubricants and their physical properties- Viscosity and other properties of oils –Additives- and selection of Lubricants- Lubricants standards ISO,SAE,AGMA, BIS standards – Lubrication Regimes –Solid Lubrication-Dry and marginally lubricated contacts- Boundary Lubrication- Hydrodynamic lubrication — Elasto and plasto hydrodynamic - Magneto hydrodynamic lubrication – Hydro static lubrication – Gas lubrication.		
UNIT IV	THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION	12
Reynolds Equation,-Assumptions and limitations-One and two dimensional Reynolds Equation-Reynolds and Sommerfeld boundary conditions- Pressure wave, flow, load capacity and friction calculations in Hydrodynamic bearings-Long and short bearings-Pad bearings and Journal bearings-Squeeze film effects-Thermal considerations-Hydrostatic lubrication of Pad bearing- Pressure , flow , load and friction calculations-Stiffness considerations- Various types of flow restrictors in hydrostatic bearings		
UNIT V	HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION	10
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.		

5. K.Shanmuga Sundaram, "Hydraulic and Pneumatic Controls: Understanding made Easy" S.Chand & Co Book publishers, New Delhi, 2006 (Reprint 2009).

ED 9256

ADVANCED TOOL DESIGN

L T P C
3 0 0 3

UNIT I INTRODUCTION TO TOOL DESIGN 8

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

UNIT II DESIGN OF CUTTING TOOLS 9

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

UNIT III DESIGN OF JIGS AND FIXTURES 10

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

UNIT IV DESIGN OF PRESS TOOL DIES 10

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

UNIT V TOOL DESIGN FOR CNC MACHINE TOOLS 8

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

TOTAL: 45 PERIODS

REFERENCES:

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

ED 9223 MECHANISMS DESIGN AND SIMULATION L T P C

3 0 2 4

UNIT I INTRODUCTION 9

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

UNIT II KINEMATIC ANALYSIS 9

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

UNIT III PATH CURVATURE THEORY, COUPLER CURVE 9

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

UNIT IV SYNTHESIS OF FOUR BAR MECHANISMS 9

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

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

Cognate Linkages-parallel motion Linkages. Design of six bar mechanisms-single dwell-double dwell-double stroke. Geared five bar mechanism-multi-dwell. Cam Mechanisms-determination of optimum size of cams. Mechanism defects. Study and use of Mechanism using Simulation Soft-ware packages. Students should design and fabricate a mechanism model as term project.

Total 45 + 30 = 75 PERIODS

NOTE: TUTORIAL / PRACTICE: 30 PERIODS

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 Mallik, "Theory of Mechanism and Machines", EWLP, Delhi, 1999.

UNIT I RELIABILITY CONCEPT 9

Reliability definition – Quality and Reliability– Reliability mathematics – Reliability functions – Hazard rate – Measures of Reliability – Design life –A priori and posteriori probabilities – Mortality of a component –Bath tub curve – Useful life.

UNIT II FAILURE DATA ANALYSIS 11

Data collection –Empirical methods: Ungrouped/Grouped, Complete/Censored data – Time to failure distributions: Exponential, Weibull – Hazard plotting – Goodness of fit tests.

UNIT III RELIABILITY ASSESSMENT 10

Different configurations – Redundancy – m/n system – Complex systems: RBD – Baye's method – Cut and tie sets – Fault Tree Analysis – Standby system.

UNIT IV RELIABILITY MONITORING 8

Life testing methods: Failure terminated – Time terminated – Sequential Testing – Reliability growth monitoring – Reliability allocation – Software reliability.

UNIT V RELIABILITY IMPROVEMENT 7

Analysis of downtime – Repair time distribution – System MTTR – Maintainability prediction – Measures of maintainability – System Availability – Replacement theory.

TOTAL: 45 PERIODS**REFERENCES:**

1. Charles E. Ebeling, "An introduction to Reliability and Maintainability engineering", TMH, 2000.
2. Roy Billington and Ronald N. Allan, "Reliability Evaluation of Engineering Systems", Springer, 2007.

CC 9259 MAINTENANCE ENGINEERING AND MANAGEMENTL T P C
3 0 0 3**UNIT I INTRODUCTION 6**

Maintenance definition – Maintenance objectives – Maintenance management –Functions of maintenance department – Tero technology – Maintenance costs.

UNIT II MAINTENANCE MODELS 12

Maintenance policies – Imperfect maintenance – PM versus b/d maintenance – Optimal PM schedule and product characteristics – Inspection decisions: Maximizing profit – Minimizing downtime – Replacement models.

UNIT III MAINTENANCE LOGISTICS 11

Maintenance staffing – Human factors –Resource requirements: Optimal size of service facility – Optimal repair effort – Maintenance planning and scheduling – Spares planning – Capital spare.

UNIT IV MAINTENANCE QUALITY 8
Five Zero concept –FMECA – Maintainability prediction– Design for maintainability – Maintainability allocation – Reliability Centered Maintenance.

UNIT IV TOTAL PRODUCTIVE MAINTENANCE 8
TPM fundamentals – Chronic and sporadic losses – Six big losses – OEE as a measure – TPM pillars– Autonomous maintenance –TPM implementation.

TOTAL: 45 PERIODS

REFERENCES

1. Andrew K.S.Jardine & Albert H.C.Tsang, "Maintenance, Replacement and Reliability", Taylor and Francis, 2006.
2. Bikas Badhury & S.K.Basu, "Tero Technology: Reliability Engineering and Maintenance Management", Asian Books, 2003.
3. Seichi Nakajima, "Total Productive Maintenance", Productivity Press, 1993.

**CC 9250 MECHATRONICS IN MANUFACTURING SYSTEMS LT P C
3 0 0 3**

UNIT I INTRODUCTION 9
Introduction to Mechatronics - Systems - Mechatronics in Products - Measurement Systems - Control Systems - Traditional design and Mechatronics Design.

UNIT II SENSORS AND TRANSDUCERS 9
Introduction - Performance Terminology - Displacement, Position and Proximity - Velocity and Motion - Fluid pressure - Temperature sensors - Light sensors - Selection of sensors - Signal processing - Servo systems.

UNIT III MICROPROCESSORS IN MECHATRONICS 9
Introduction - Architecture - Pin configuration - Instruction set - Programming of Microprocessors using 8085 instructions - Interfacing input and output devices - Interfacing D/A converters and A/D converters –Applications - Temperature control - Stepper motor control - Traffic light controller.

UNIT IV PROGRAMMABLE LOGIC CONTROLLERS 9
Introduction - Basic structure - Input / Output processing - Programming -Mnemonics Timers, Internal relays and counters - Data handling - Analog input / output - Selection of PLC.

UNIT V DESIGN AND MECHATRONICS 9
Designing - Possible design solutions - Case studies of Mechatronics systems.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Michael B.Histand and David G. Alciatore, " Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, 1999.
2. Bradley, D.A., Dawson, D, Buru, N.C. and Loader, AJ, "Mechatronics ", Chapman and Hall, 1993.
3. Ramesh.S, Gaonkar, "Microprocessor Architecture, Programming and Applications" Wiley Eastern, 1998.
4. Lawrence J.Kamm, " Understanding Electro-Mechanical Engineering, An Introduction to Mechatronics ", Prentice-Hall, 2000.

- Ghosh, P.K. and Sridhar, P.R., 0000 to 8085, "Introduction to Microprocessors for Engineers and Scientists ", Second Edition, Prentice Hall, 1995.

WEB REFERENCE:

- www.cs.indiana.edu.

CC 9251

COMPUTER AIDED PROCESS PLANNING

**LT P C
3 0 0 3**

UNIT I INTRODUCTION 9

The Place of Process Planning in the Manufacturing cycle - Process Planning and Production Planning – Process Planning and Concurrent Engineering, CAPP, Group Technology.

UNIT II PART DESIGN REPRESENTATION 9

Design Drafting - Dimensioning - Conventional tolerance - Geometric tolerance - CAD - input / output devices - topology - Geometric transformation - Perspective transformation - Data structure - Geometric modelling for process planning - GT coding - The optiz system - The MICLASS system.

UNIT III PROCESS ENGINEERING AND PROCESS PLANNING 9

Experienced, based planning - Decision table and decision trees - Process capability analysis - Process Planning - Variant process planning - Generative approach - Forward and Backward planning, Input format, AI.

UNIT IV COMPUTER AIDED PROCESS PLANNING SYSTEMS 9

Logical Design of a Process Planning - Implementation considerations -manufacturing system components, production Volume, No. of production families - CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP.

UNIT V AN INTERGRADED PROCESS PLANNING SYSTEMS 9

Totally integrated process planning systems - An Overview - Modulus structure - Data Structure, operation - Report Generation, Expert process planning.

TOTAL: 45 PERIODS

REFERENCES:

- Gideon Halevi and Roland D. Weill, " Principles of Process Planning ", A logical approach, Chapman & Hall, 1995.
- Tien-Chien Chang, Richard A.Wysk, "An Introduction to automated process planning systems ", Prentice Hall, 1985.
- Chang, T.C., " An Expert Process Planning System ", Prentice Hall, 1985.
- Nanua Singh, " Systems Approach to Computer Integrated Design and Manufacturing ", John Wiley & Sons, 1996.
- Rao, "Computer Aided Manufacturing ", Tata McGraw Hill Publishing Co., 2000.

WEB REFERENCES:

- <http://claymore.engineer.gusu.edu/jackh/eod/automate/capp/capp.htm>
- <http://Estraj.ute.sk/journal/engl/027/027.htm>

UNIT I MEASURING MACHINES 9

Tool Maker's microscope - Co-ordinate measuring machines - Universal measuring machine - Laser viewers for production profile checks - Image shearing microscope - Use of computers - Machine vision technology - Microprocessors in metrology.

UNIT II STATISTICAL QUALITY CONTROL 9

Data presentation - Statistical measures and tools - Process capability - Confidence and tolerance limits - Control charts for variables and for fraction defectives - Theory of probability - Sampling - ABC standard - Reliability and life testing.

UNIT III LIQUID PENETRANT AND MAGNETIC PARTICLE TESTS 9

Characteristics of liquid penetrants - different washable systems - Developers - applications - Methods of production of magnetic fields - Principles of operation of magnetic particle test - Applications - Advantages and limitations.

UNIT III RADIO GRAPHY 9

Sources of ray-x-ray production - properties of d and x rays - film characteristics - exposure charts - contrasts - operational characteristics of x ray equipment - applications.

UNIT IV ULTRASONIC AND ACOUSTIC EMISSION TECHNIQUES 9

Production of ultrasonic waves - different types of waves - general characteristics of waves - pulse echo method - A, B, C scans - Principles of acoustic emission techniques - Advantages and limitations - Instrumentation - applications.

TOTAL: 45 PERIODS

REFERENCES:

1. JAIN, R.K. " Engineering Metrology ", Khanna Publishers, 1997.
2. Barry Hull and Vernon John, " Non Destructive Testing ", MacMillan, 1988.
3. American Society for Metals, " Metals Hand Book ", Vol.II, 1976.
4. Progress in Acoustic Emission, " Proceedings of 10th International Acoustic Emission Symposium ", Japanese Society for NDI, 1990.

WEB REFERENCES:

1. www.metrologytooling.com
2. www.sisndt.com
3. www.iuk'tu-harburg.de

UNIT I ELASTICITY 9

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

UNIT II SHEAR CENTER AND UNSYMMETRICAL BENDING 10

Location of shear center for various thin sections - shear flows. Stresses And deflections

in beams subjected to unsymmetrical loading-kern of a section.

UNIT III CURVED FLEXIBLE MEMBERS AND STRESSES IN FLAT PLATES 10

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

UNIT IV TORSION OF NON-CIRCULAR SECTIONS 7

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

UNIT V STRESSES IN ROTARY SECTIONS AND CONTACT STRESSES 9

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

TOTAL: 45 PERIODS

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.

ED 9259 DESIGN OF MATERIAL HANDLING EQUIPMENTS L T P C
(Use of Approved Data Book Is Permitted) 3 0 0 3

UNIT I MATERIALS HANDLING EQUIPMENT 5

Types, selection and applications

UNIT II DESIGN OF HOISTS 10

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

UNIT III DRIVES OF HOISTING GEAR 10

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

UNIT IV CONVEYORS 10

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

UNIT V ELEVATORS**10**

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

TOTAL: 45 PERIODS**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

CC 9252**DATA COMMUNICATION IN CAD / CAM****LT P C
3 0 0 3****UNIT I DIGITAL COMPUTERS & MICRO PROCESSORS****9**

Block diagram - register transfer language - arithmetic, logic and shift micro operations - instruction code - training and control instruction cycle - I/O and interrupt design of basic computer. Machine language - assembly language - assembler.

Registers ALU and Bus Systems - timing and control signals - machine cycle and timing diagram - functional block diagrams of 80 x 86 and modes of operation. Features of Pentium Processors

UNIT II OPERATING SYSTEM & ENVIRONMENTS**9**

Types - functions - UNIX & WINDOWS NT - Architecture - Graphical User Interfaces.

Compilers - Analysis of the Source program - the phases of a compiler - cousins of the compiler, the grouping of phases - compiler construction tools.

UNIT III COMMUNICATION MODEL**9**

Data communication and networking - protocols and architecture - data transmission concepts and terminology - guided transmission media - wireless transmission - data encoding - asynchronous and synchronous communication - base band interface standards RS232C, RS449 interface.

UNIT IV COMPUTER NETWORKS**9**

Network structure - network architecture - the OSI reference model services - network standardization – example - Managing remote systems in network - network file systems - net working in manufacturing.

UNIT V INTERNET**9**

Internet services - Protocols - intranet information services - mail based service - system and network requirements - Internet tools - usenet - e-mail - IRC - www - FTP - Telnet.

TOTAL: 45 PERIODS

REFERENCES:

1. Morris Mano. M., "Computer System Architecture", Prentice Hall of India, 1996.
2. Gaonkar R.S., "Microprocessor Architecture, Programming and Applications of 8085", Penram International, 1997
3. Peterson J.L., Galvin P. and Silberschaz, A., "Operating Systems Concepts", Addison Wesley, 1997.
4. Alfred V. Aho, Ravi Setjhi, Jeffrey D Ullman, "Compilers Principles Techniques and Tools", Addison Wesley, 1986.
5. William Stallings, "Data of Computer Communications" Prentice Hall of India, 1997.
6. Andrew S. Tanenbanum "Computer Networks", Prentice Hall of India 3rd Edition, 1996.
7. Christian Crumlish, "The ABC's of the Internet", BPB Publication, 1996.

CC 9253

INDUSTRIAL SAFETY MANAGEMENT

**LT P C
3 0 0 3**

UNIT I SAFETY MANAGEMENT 9

Evaluation of modern safety concepts - Safety management functions - safety organization, safety department - safety committee, safety audit - performance measurements and motivation - employee participation in safety - safety and productivity.

UNIT II OPERATIONAL SAFETY 9

Hot metal Operation - Boiler, pressure vessels - heat treatment shop - gas furnace operation - electroplating-hot bending pipes - Safety in welding and cutting. Cold-metal Operation - Safety in Machine shop - Cold bending and chamfering of pipes - metal cutting - shot blasting, grinding, painting - power press and other machines.

UNIT III SAFETY MEASURES 9

Layout design and material handling - Use of electricity - Management of toxic gases and chemicals - Industrial fires and prevention - Road safety - highway and urban safety - Safety of sewage disposal and cleaning - Control of environmental pollution - Managing emergencies in Industries - planning, security and risk assessments, on- site and off site. Control of major industrial hazards.

UNIT IV ACCIDENT PREVENTION 9

Human side of safety - personal protective equipment - Causes and cost of accidents. Accident prevention programmes - Specific hazard control strategies - HAZOP - Training and development of employees - First Aid- Fire fighting devices - Accident reporting, investigation.

UNIT V SAFETY, HEALTH, WELFARE & LAWS 9

Safety and health standards - Industrial hygiene - occupational diseases prevention - Welfare facilities - History of legislations related to Safety-pressure vessel act-Indian boiler act - The environmental protection act - Electricity act - Explosive act.

TOTAL: 45 PERIODS

UNIT V PETRI NETS**9**

Classical Petri Nets - Definitions - Transition firing and reachability - Representational power - properties - Manufacturing models. Stochastic Petri Nets - Exponential timed Petri Nets - Generalized Stochastic Petri Nets - modelling of KANBAN systems - Manufacturing models.

TOTAL: 45 PERIODS**REFERENCES:**

1. Viswanadham, N and Narahari, Y. "Performance Modelling of Automated Manufacturing Systems", Prentice Hall of India, New Delhi, 1994.
2. Trivedi, K.S., "Probability and Statistics with Reliability, Queuing and Computer Science Applications", Prentice Hall, New Jersey, 1982.
3. Gupta S.C., & Kapoor V.K., "Fundamentals of Mathematical Statistics", 3rd Edition, Sultan Chand and Sons, New Delhi, 1988.

CI 9259**RAPID PROTOTYPING****L T P C****3 0 0 3****AIM:**

To provide knowledge on different types of Rapid Prototyping systems and its applications in various fields.

OBJECTIVE:

Generating a good understanding of RP history, its development and applications. Expose the students to different types of Rapid prototyping processes, materials used in RP systems and reverse engineering.

UNIT I INTRODUCTION**8**

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

UNIT II REVERSE ENGINEERING AND CAD MODELING**10**

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

UNIT III LIQUID BASED AND SOLID BASED RAPID PROTOTYPING SYSTEMS**10**

Stereolithography (SLA): Apparatus: Principle, per-build process, part-building, post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications.

Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. laminated object manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

UNIT IV POWDER BASED RAPID PROTOTYPING SYSTEMS 10
 Selective Laser Sintering(SLS): Principle, process, Indirect and direct SLS- powder structures, modeling of SLS, materials, post processing, post curing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping(LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

UNIT V OTHER RAPID PROTOTYPING TECHNOLOGIES 7
 Three dimensional Printing (3DP):Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM): Introduction, basic process, shape decomposition, mold SDM and applications. Selective Laser Melting, Electron Beam Melting – Rapid manufacturing.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Rapid prototyping: Principles and applications, second edition, Chua C.K., Leong K.F., and Lim C.S., World Scientific Publishers, 2003.
2. Rapid prototyping, Andreas Gebhardt, Hanser Gardener Publications, 2003.

REFERENCES:

1. Rapid Prototyping and Engineering applications : A tool box for prototype development, Liou W.Liou, Frank W.Liou, CRC Press, 2007.
2. Rapid Prototyping: Theory and practice, Ali K. Kamrani, Emad Abouel Nasr, Springer, 2006.
3. Rapid Tooling: Technologies and Industrial Applications, Peter D.Hilton, Hilton/Jacobs, Paul F.Jacobs, CRC press, 2000.

**ED 9258 INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS L T P C
 3 0 0 3**

UNIT I INTRODUCTION AND ROBOT KINEMATICS 10
 Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors. Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

UNIT II ROBOT DRIVES AND CONTROL 9
 Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

UNIT III ROBOT SENSORS 9
 Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system.

UNIT IV VIBRATION CONTROL 9
 Specification of Vibration Limits –Vibration severity standards- Vibration as condition Monitoring tool-Vibration Isolation methods- -Dynamic Vibration Absorber, Torsional and Pendulum Type Absorber- Damped Vibration absorbers-Static and Dynamic Balancing- Balancing machines-Field balancing – Vibration Control by Design Modification- - Active Vibration Control

UNIT V EXPERIMENTAL METHODS IN VIBRATION ANALYSIS 10
 Vibration Analysis Overview - Experimental Methods in Vibration Analysis.-Vibration Measuring Instruments - Selection of Sensors- Accelerometer Mountings. -Vibration Exciters-Mechanical, Hydraulic, Electromagnetic And Electrodynamics –Frequency Measuring Instruments-. System Identification from Frequency Response -Testing for resonance and mode shapes.

TOTAL: 75 PERIODS

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

TEXT BOOKS :

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.

**CC9256 DESIGN OF CELLULAR MANUFACTURING SYSTEM L T P C
 3 0 0 3**

AIM:

To impart knowledge on group technology, optimization algorithms, implementation of GT/CMS, Performance measurements and economical aspects of CMS.

OBJECTIVE:

At the end of this course the student should be able to understand

- Concepts and applications of Cellular manufacturing systems
- Traditional and non-traditional approaches of Problem solving
- Performance measurement
- Human and economical aspects of CMS.

UNIT I INTRODUCTION 12
 Introduction to Group Technology, Limitations of traditional manufacturing systems, characteristics and design of groups, benefits of GT and issues in GT.

UNIT II CMS PLANNING AND DESIGN 10
 Problems in GT/CMS - Design of CMS - Models, traditional approaches and non-traditional approaches -Genetic Algorithms, Simulated Annealing, Neural networks.

