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. (CAD / CAM) PROGRAMME

(I TO IV SEMESTERS)

REGULATIONS AND SYLLABI

(REGULATIONS – 2013)

(With a retrospective amendment in the credits from the batch of students admitted in 2014-15)

M.E. (CAD / CAM) PROGRAMME

Regulations and Syllabi

(Effective from the Academic Year 2013-'14)

(With a retrospective amendment in the credits from the batch of students admitted in 2014-15)

1. **Eligibility:** Candidates who passed B.E. / B.Tech.(Mechanical Engineering / Automobile / Manufacturing / Production / Industrial Engineering / Mechatronics) of the University or A.M.I.E. with concerned subject or the equivalent examination thereto are eligible for admission to Two Year M.E.(CAD/CAM) Programme.

2. **Duration:** Two Years Comprising 4 Semesters. Each semester has a minimum 90 working days with a minimum of 5 hours a day a minimum of 450 hours per Semester. Candidates who have completed the duration of the programme of study are permitted to appear for the arrear subjects examinations, if any within two years after the duration of the programme.

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

4. **Weightage for Internal and End Assessment:** The weightage for Internal Assessment (CA) and End Assessment (EA) is 25:75 unless the ratio is specifically mentioned in the scheme of Examinations. The question paper is to be set for a maximum of 100 Marks.

5. **Choice Based Credit System:** Choice Based Credit System is followed with one credit equivalent to one hour for a theory paper and two hours for a practical per week in a cycle of 18 weeks (that is, one credit is equal to 18 hours for each theory paper and one credit is equal to 36 hours for a practical in a semester) in the Time Table. The total credit for the programme (4 semesters) is 90.

6. **Scheme of Examinations**

I Semester

Code No.	Course Title	L	T	P	C
Theory					
113CCPT01	Advanced Numerical Methods	3	1	0	4
113CCPT02	Computer Applications in Design	3	0	2	4
113CCPT03	Integrated Mechanical Design	3	1	0	4
113CCPT04	Competitive Manufacturing Systems	3	0	0	4
113CCPT05	Finite Element Applications in Manufacturing Engineering	3	1	0	4
Electives					
113CCPT07	**Elective I :** Optimization Techniques in Design	3	0	0	4
Practical					
113CCPP01	CAD / CAE Laboratory	0	0	2	3
	Total	**18**	**3**	**4**	**27**

II Semester

Code No.	Course Title	L	T	P	C
Theory					
213CCPT01	Design for Manufacture Assembly and Environments	3	0	0	4
213CCPT02	Additive Manufacturing	3	0	0	4
213CCPT03	Applied Materials Engineering	3	0	0	4
213CCPT04	Integrated Product and Processes Development	3	1	0	4
Electives					
213CCPT09	**Elective II:** Computational Fluid Dynamics	3	0	0	4
213CCPT10	**Elective III:** Reliability in Engineering Systems	3	0	0	4
Practical					
213CCPP01	CAM Laboratory	0	0	2	1
213CCPP02	Design Project	0	0	3	2
	Total	**18**	**1**	**5**	**27**

III Semester

Code No.	Course Title	L	T	P	C
Electives					
313CCPT04	**Elective IV:** Tribology in Design	3	0	0	4
313CCPT02	**Elective V:** Data Communication in CAD/CAM	3	0	0	4
313CCPT01	**Elective VI:** Design of Hydraulic and Pneumatic Systems	3	0	0	4
Project					
313CCPP01	Project Work (Phase I)*	0	0	12	8
	Viva Voce				
	Total	**9**	**0**	**12**	**20**

***** Candidates who have completed Project work (Phase I) successfully are eligible for Project Work (Phase - II) Examination.

IV Semester

Code No.	Course Title	L	T	P	C
Project					
413CCPP01	Project Work (Phase – II)*	0	0	24	16
	Viva Voce				
	Total	**0**	**0**	**24**	**16**

LIST OF ELECTIVES

Course Code	Electives	L	T	P	C
	I Semester				
113CCPT06	Computer Control in Process Planning	3	0	0	4
113CCPT07	Optimization Techniques in Design	3	0	0	4
113CCPT08	Advanced Mechanics of Materials	3	0	0	4
113CCPT09	Design of Material Handling Equipments	3	0	0	4
	II Semester				
213CCPT05	Mechatronics Applications in Manufacturing	3	0	0	4
213CCPT06	Industrial Safety Management	3	0	0	4
213CCPT07	Advanced Tool Design	3	0	0	4
213CCPT08	Mechanisms Design and Simulation	3	0	0	4
213CCPT09	Computational Fluid Dynamics	3	0	0	4
213CCPT10	Reliability in Engineering Systems	3	0	0	4
213CCPT11	Industrial Robotics and Expert Systems	3	0	0	4
	III Semester				
313CCPT01	Design of Hydraulic and Pneumatic Systems	3	0	0	4
313CCPT02	Data Communication in CAD/CAM	3	0	0	4
313CCPT03	Performance Modelling and Analysis of Manufacturing System	3	0	0	4
313CCPT04	Tribology in Design	3	0	0	4
313CCPT05	Metrology and Non Destructive Testing	3	0	0	4
313CCPT06	Quality Management Techniques	3	0	0	4
313CCPT07	Design for Cellular Manufacturing Systems	3	0	0	4

7. **Passing Requirements:** The minimum pass mark (raw score) be 50% in End Assessment (EA) and 50% in Continuous Assessment (CA) and End Assessment (EA) put together. No minimum mark (raw score) in Continuous Assessment (CA) 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 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

113CCPT01 ADVANCED NUMERICAL METHODS

OBJECTIVES:

- To develop the ability to apply the concepts of Matrix theory and Liner programming in Engineering problems.
- To familiarize the students in calculus of variations
- To improve knowledge on numerical methods that will come in handy to solve numerically the problems that arise in engineering and technology. This will also serve as precursor for further research.

1. CALCULUS 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.

2. MATRIX THEORY

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

3. LINEAR PROGRAMMING PROBLEM

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

4. ALGEBRAIC EQUATIONS

Systems of linear equations: Gauss Elimination method, pivoting techniques, Thomas algorithm for tridiagonal system – Jacobi, Gauss Seidel, SOR iteration methods - Systems of nonlinear equations: Fixed point iterations, Newton Method, Eigenvalue problems: power method, inverse power method, Faddeev – Leverrier Method.

5. FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS

Laplace and Poisson's equations in a rectangular region: Five point finite difference schemes, Leibmann's iterative methods, Dirichlet and Neumann conditions – Laplace equation in polar coordinates: finite difference schemes – approximation of derivatives near a curved boundary while using a square mesh.

REFERENCES:

1. Gupta, A.S., Calculus of Variations with Applications, Prentice – Hall of India, New Delhi, 1997.
2. Bronson R, :Matrix Operation" Schaums Outline Series, Mc Graw Hill, New York, 1989.
3. Taha H.A., "Operation Research an Introduction", Prentice Hall of India, 2001.
4. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
5. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", Cengage Learning, India Edition, New Delhi, 2009.
6. Jain M. K., Iyengar S. R., Kanchi M. B., Jain , "Computational Methods for Partial Differential Equations", New Age Publishers,1993.

113CCPT02 COMPUTER APPLICATIONS IN DESIGN

OBJECTIVES:
To impart knowledge on computer graphics which are used routinely in diverse areas as science, engineering, medicine, etc.

OUTCOME:
With laboratory classes in conjunction, It helps the students to get familiarized with the computer graphics application in design. This understanding reinforces the knowledge being learned and shortens the overall learning curves which are necessary to solve CAE problems that arise in engineering.

UNIT I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS
Output primitives (points, lines, curves etc.,), 2-D & 3-D transformation (Translation, scaling, rotators) windowing - view ports - clipping transformation.

UNIT II CURVES AND SURFACES MODELLING
Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline- Bezier curve and B-Spline curve – curve manipulations.
Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface , surface of revolution and tabulated cylinder – synthetic surfaces: Hermite bicubic surface- Bezier surface and B-Spline surface- surface manipulations.

UNIT III NURBS AND SOLID MODELING
NURBS- Basics- curves , lines, arcs, circle and bi linear surface. Regularized Boolean set operations - primitive instancing - sweep representations - boundary representations - constructive solid Geometry - comparison of representations - user interface for solid modeling.

UNIT IV 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.

UNIT V ASSEMBLY OF PARTS AND PRODUCT DATA EXCHANGE
Assembly modeling - interferences of positions and orientation - tolerances analysis - mass property calculations - mechanism simulation.
Graphics and computing standards– Open GL Data Exchange standards – IGES, STEP etc– Communication standards. Laboratory session: Writing interactive programs generate graphics and to solve design problems - using any languages like Auto LISP/ C / FORTRAN etc. Each assessment should contain a component of Laboratory session.

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. David F. Rogers, James Alan Adams "Mathematical elements for computer graphics" second edition, Tata McGraw-Hill edition.

113CCPT03 INTEGRATED MECHANICAL DESIGN''
(Use of Approved Data Book Is Permitted)

UNIT I FUNDAMENTALS AND DESIGN OF SHAFTS

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

UNIT II DESIGN OF GEARS AND GEAR BOXES

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.

UNIT III BRAKES

Dynamics and thermal aspects of vehicle braking – Integrated design of brakes for machine tools, automobiles and mechanical handling equipments.

UNIT IV INTEGRATED DESIGN

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.

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.

113CCPT04 COMPETITIVE MANUFACTURING SYSTEMS

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
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
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:
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
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.

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.

113CCPT05 FINITE ELEMENT APPLICATIONS IN MANUFACTURING ENGINEERING

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:
Basics of FEM – Initial value and boundary value problems – wighted residual Galerkin ands Raleigh Ritz methods – review of Variational calculus – Integration by parts – Basics of variational formulation.

UNIT II ONE DIMENSIONAL ANALYSIS:
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
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
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
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.

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.

113CCPP01 CAD/CAE LAB

OBJECTIVE:

To impart knowledge on how to prepare drawings for various mechanical components using any commercially available 3D modeling software's

To impart knowledge on the use of Finite Element Analysis software to solve various field problems in mechanical engineering to optimize and verify the design of machine elements.

OUTCOME:

With laboratory classes, it helps the students to get familiarized with the computer applications in design and preparing drawings for various mechanical components.

Model and analyze various physical problems

Select appropriate elements and give boundary conditions

Solve structural, thermal, modal and dynamics problems.

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

Analysis of Mechanical Components – Use of FEA Packages like ANSYS/ NASTRAN etc.,

Exercises shall include analysis of

i) Machine elements under Static loads

ii) Thermal Analysis of mechanical systems

iii) Modal Analysis

iv) Machine elements under Dynamic loads

v) Non-linear systems

II Semester

213CCPT01 DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENTS

OBJECTIVES:
To know the concept of design for manufacturing, assembly and environment.
To know the computer application in design for manufacturing and assembly.

OUTCOME:
To make the students get acquainted with the design for manufacturing, assembly and environment.

UNIT I 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.

UNIT II 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.

UNIT III 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.

UNIT IV 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

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

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.

213CCPT02 ADDITIVE MANUFACTURING

OBJECTIVE:

To educate students with fundamental and advanced knowledge in the field of Additive manufacturing technology and the associated Aerospace, Architecture, Art, Medical and industrial applications.

OUTCOME:

On completion of this course, they will learn about a variety of Additive Manufacturing (AM) technologies, their potential to support design and manufacturing, case studies relevant to mass customized manufacturing, and some of the important research challenges associated with AM and its data processing tools

UNIT I INTRODUCTION:

Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes-Benefits-Applications.

UNIT II 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, Tool path generation-Software for AM- Case studies.

UNIT III LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS:

Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and 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 ADDITIVE MANUFACTURING SYSTEMS: 10

Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

UNIT V OTHER ADDITIVE MANUFACTURING SYSTEMS: 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), Ballastic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting.

REFERENCES

1. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
2. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.
3. Gebhardt, A., "Rapid prototyping", Hanser Gardener Publications, 2003.
4. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications : A tool box for prototype development", CRC Press, 2011.
5. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
6. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.

213CCPT03 APPLIED MATERIALS ENGINEERING

OBJECTIVE:

This course provides knowledge in the areas of Industrial metallurgy, advanced materials and selection of materials for industrial applications.

UNIT I ELASTIC AND PLASTIC BEHAVIOUR

Mechanism of Elastic and Plastic deformation, Anelasticity and viscoelasticity- role of dislocations, yield stress, shear strength of perfect and real crystals –Strengthening mechanism, work, hardening, solid solutioning, grain boundary strengthening, Poly phase mixture, precipitation, particle fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviour – Super plasticity.

UNIT II FRACTURE BEHAVIOUR

Griffith's theory - stress intensity factor and fracture toughness-Toughening mechanisms – Ductile, brittle transition in steel-High temperature fracture, creep – Larson-Miller, Parameter – Deformation and fracture mechanism maps – Fatigue. Low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law – Residual Life Estimation- Effect of surface and metallurgical parameters on fatigue – fracture of non metallic materials – Failure analysis, sources of failure, procedure of failure analysis.

UNIT III SELECTION OF MATERIALS

Motivation, 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**.**

UNIT IV MATERIAL PROCESSING

Processing of engineering materials – Primary and Secondary processes – astability, Weldability, forgeability and malleability Criteria – Process induced defects – Monitoring and control.

UNIT V MODERN MATERIALS AND TREATMENT

Dual phase steels, high strength low alloy steel, transformation included plasticity steel, maraging steel, smart materials, properties and applications of engineering plastics and composites materials - advanced structural ceramics – WC, TiC, TaC, Al2O3, SiC, Si3N4, CBN, diamond – Plasma, PVD, CVD- thick and thin film deposition – Functionally Gradient Materials , Nano materials

OUTCOME:

At the end of this course the student will be able to select the materials for Engineering applications by understanding basic mechanical properties of materials, the relation of the microstructure and mechanical properties, processing techniques for controlling shape and properties in the final product and able to work in R&D activity in the field of materials science.

REFERENCES:

1. Dieter, G.E., "Mechanical Metallurgy", McGraw Hill, 1988.
2. Charles, J.A., Crane, F.A.A and Furness, J.A.G., "Selection and use of engineering Materials", (3 rd Edition, Butterworth – Heiremann, 1977.
3. James, K.W., Wiley, Intersam, John, "The Hand book of Advance Materials", Wilson Publishers., 2004.
4. Burakonsa, T.Z. and Wierzchan. T.,"Surface Engg of Meterials"- Principles of Equipment, Techniques.
5. Courtney, T.H.,"Mechanical Behavior of Materials" ,(2nd edition), McGraw Hill, 2000.
6. Flinn,R.A.and Trojan ,P.K.., "Engineering Materials and their Applications" (4th Edition), Jaico, 1999.
7. Metals hand book, vol. 10, "Failure Analysis and Prevention",(10th edition), 1994.

WEB REFERENCES:

1. www.astm.org/labs/pages/131350.htm

2. www.appliedmaterials.com/carrers/agu-ei.html

213CCPT04 INTEGRATED PRODUCT DESIGN AND PROCESS DEVELOPMENT

UNIT I INTRODUCTION

Need for IPPD-Strategic importance of Product development - integration of customer, designer, material supplier and process planner, Competitor and customer - behavior analysis. Understanding customer-promoting customer understanding-involve customer in development and managing requirements - Organization process management and improvement

UNIT II CONCEPT GENERATION, SELECTION AND TESTING

Plan and establish product specifications. Task - Structured approaches - clarification - searchexternally and internally-Explore systematically - reflect on the solutions and processes - concept selection - methodology - benefits. Implications - Product change - variety - component standardization - product performance - manufacturability – Concept Testing Methodologies.

UNIT III PRODUCT ARCHITECTURE

Product development management - establishing the architecture - creation - clustering - geometric layout development - Fundamental and incidental interactions - related system level design issues - secondary systems -architecture of the chunks - creating detailed interface specifications-Portfolio Architecture.

UNIT IV INDUSTRIAL DESIGN

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

UNIT V DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT

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

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

TEXT BOOK:

1. Product Design and Development, Karl T.Ulrich and Steven D.Eppinger, McGraw –Hill International Edns.1999

REFERENCES

1. Concurrent Engg./Integrated Product Development. Kemnneth Crow, DRM Associates, 6/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book
2. Effective Product Design and Development, Stephen Rosenthal, Business One Orwin, Homewood, 1992,ISBN, 1-55623-603-4
3. Tool Design – Integrated Methods for successful Product Engineering, Stuart Pugh, Addison Wesley Publishing,Neyourk,NY,1991, ISBN 0-202-41639-5
4. www.me.mit/2.7444.

213CCPP01 CAM LAB

Simulation and Machining using CNC / DNC Machine Tools – Use of FEM Packages - Relational Data Base – Networking – Practice on Computer Aided Measuring Instruments - Image Processing – Software Development for Manufacturing – CNC Controllers – Use of advanced CNC Machining Packages – Business Data Processing.

EQUIPMENTS FOR CAM LAB

1. CAM Software for tool path generation for planer machining, contour machining, drilling, turning etc. & post processing modulus for different CNC controllers : 10 Nos
2. Medium production type CNC turning center with popular industrial type controller : 1
3. Medium production type CNC machining center with popular industrial type controller : 1
4. Bench Model CMM : 1
5. Vision & image processing software : 2
6. Data Processing Software : 2

213CCPP02 DESIGN PROJECT

OBJECTIVE:

It is proposed to carryout detailed design calculations and analysis of any mechanical component or mechanical system. This helps the students to get familiar with respect to the design methodologies applied to any component or mechanical system subjected to static, dynamic and thermo-mechanical loads.

OUTCOME:

It helps the students to get familiarized with respect to design standards, design calculations and analysis in designing any mechanical component or system. Each student is required to select any new component or an integrated mechanical system that involves various sub components which are to be designed as per design standards and further required to be analyzed for optimum dimensions with respect to the strength and stiffness.

LIST OF ELECTIVES

113CCPT06 COMPUTER CONTROL IN PROCESS PLANNING

UNIT I INTRODUCTION
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
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
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
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.

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

WEB REFERENCES:
1. http://claymore.engineer.gusu.edu/jackh/eod/automate/capp/capp.htm
2. http://Estraj.ute.sk/journal/engl/027/027.htm

113CCPT07 OPTIMIZATION TECHNIQUES IN DESIGN

UNIT I 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.

UNIT II CONSTRAINED OPTIMIZATION TECHNIQUES

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

UNIT III ADVANCED OPTIMIZATION TECHNIQUES

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

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

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

113CCPT08 ADVANCED MECHANICS OF MATERIALS

OBJECTIVES:

To know the fundamentals of mechanics of materials under various loading conditions.

UNIT I 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.

UNIT II 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.

UNIT III STRESSES IN FLAT PLATES AND CURVED MEMBERS

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

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

UNIT V STRESSES IN ROTATING MEMBERS 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.

OUTCOME:

It helps the students to be familiarized with the stresses under different loading conditions.

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", Mc-millan 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.
6. Allan F. Bower, “Applied Mechanics of Solids”, CRC press – Special Indian Edition -2012, 2010
7. K. Baskar and T.K. Varadan, “Theory of Isotropic/Orthotropic Elasticity”, Ane Books Pvt. Ltd., New Delhi, 2009

113CCPT09 DESIGN OF MATERIAL HANDLING EQUIPMENTS
(Use of Approved Data Book Is Permitted)

OBJECTIVES:
To impart students on the need, use, application and design of different material handling techniques, equipments and machines used in common use and in industrial sector

OUTCOME:
The course would familiarize the student on the technique to select suitable material handling equiment and design them based on the need.

UNIT I MATERIALS HANDLING EQUIPMENT
Types, selection and applications

UNIT II 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.

UNIT III DRIVES OF HOISTING GEAR
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
Types - description - design and applications of Belt conveyors, apron conveyors and escalators Pneumatic conveyors, Screw conveyors and vibratory conveyors.

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

REFERENCES
1. Rudenko, N., Materials handling equipment, ELnvee Publishers, 1970.
2. Spivakovsy, A.O. and Dyachkov, V.K., Conveying Machines, Volumes I and II, MIR Publishers, 1985.
3. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.
4. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.
5. P.S.G. Tech., "Design Data Book", Kalaikathir Achchagam, Coimbatore, 2003.
6. Lingaiah. K. and Narayana Iyengar, "Machine Design Data Hand Book", Vol.1 & 2, Suma Publishers, Bangalore, 1983

213CCPT05 MECHATRONICS APPLICATIONS IN MANUFACTURING

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

UNIT II SENSORS AND TRANSDUCERS
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
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
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
Designing - Possible design solutions - Case studies of Mechatronics systems.

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

WEB REFERENCE:
1. www.cs.Indiana.edu

213CCPT06 INDUSTRIAL SAFETY MANAGEMENT

UNIT I SAFETY MANAGEMENT

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

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

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

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

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.

TEXT BOOKS:

1. John V. Grimaldi and Rollin H. Simonds, "Safety Management", All India Travellers bookseller, New Delhi-1989.
2. Krishnan N.V., "Safety in Industry", Jaico Publisher House, 1996.

REFERENCES:

1. Occupational Safety Manual BHEL.
2. Industrial safety and the law by P.M.C. Nair Publisher's, Trivandrum.
3. Managing emergencies in industries, Loss Prevention of India Ltd., Proceedings,1999.
4. Safety security and risk management by U.K. Singh & J.M. Dewan, A.P.H. Publishing company, New Delhi, 1996.
5. Singh, U.K. and Dewan, J.M., "Safety, Security and risk management", APH Publishing Company, New Delhi, 1996.

213CCPT07 ADVANCED TOOL DESIGN

UNIT I 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.

UNIT II 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

UNIT III 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.

UNIT IV DESIGN OF PRESS TOOL DIES

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

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.

213CCPT08 MECHANISMS DESIGN AND SIMULATION

UNIT I 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.

UNIT II 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.

UNIT III 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.

UNIT IV SYNTHESIS OF FOUR BAR MECHANISMS

Type synthesis – Number synthesis – Associated Linkage Concept. Dimensional synthesis – function generation, path generation, motion generation. Graphical methods- Pole techniqueinversion 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

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 Software packages. Students should design and fabricate a mechanism model as term project.

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.
5. Kenneth J, Waldron, Gary L. Kinzel, "Kinematics, Dynamics and Design of Machinery", John Wiley-sons, 1999.
6. Ramamurti, V., "Mechanics of Machines", Narosa, 2005.

213CCPT09 COMPUTATIONAL FLUID DYNAMICS

AIM

This course aims to introduce numerical modeling and its role in the field of heat and fluid flow, it will enable the students to understand the various discretisation methods and solving methodologies and to create confidence to solve complex problems in the field of heat transfer and fluid dynamics.

OBJECTIVES:

To develop finite difference and finite volume discretized forms of the CFD equations.
To formulate explicit & implicit algorithms for solving the Euler Eqns & Navier Stokes Eqns.

UNIT I 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.

UNIT II CONDUCTION HEAT TRANSFER

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

UNIT III 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.

UNIT IV 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.

UNIT V 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.

213CCPT10 RELIABILITY IN ENGINEERING SYSTEMS

UNIT I RELIABILITY CONCEPT

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

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

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

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

UNIT V RELIABILITY IMPROVEMENT

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

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.

213CCPT11 INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS

UNIT I 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.

UNIT II 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.

UNIT III 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 system.

UNIT IV 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.

UNIT V 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.

313CCPT01 DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS

UNIT I OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS

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

UNIT II CONTROL AND REGULATION ELEMENTS

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

UNIT III 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.

UNIT IV 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.

UNIT V 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 Publishing 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).

313CCPT02 DATA COMMUNICATION IN CAD / CAM

UNIT I DIGITAL COMPUTERS & MICRO PROCESSORS

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

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

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

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

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

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.

313CCPT03 PERFORMANCE MODELLING AND ANALYSIS OF MANUFACTURING SYSTEM

UNIT I MANUFACTURING SYSTEMS & CONTROL

Automated Manufacturing Systems - Modelling - Role of performance modelling - simulation models- Analytical models. Product cycle - Manufacturing automation - Economics of scale and scope - input/output model - plant configurations. Performance measures - Manufacturing leadtime - Work in process -Machine utilization - Throughput – Capacity - Flexibility - performability - Quality. Control Systems - Control system architecture - Factory communications - Local area networks - Factory net works - Open systems interconnection model - Net work to network interconnections - Manufacturing automation protocol - Database management system.

UNIT II MANUFACTURING PROCESSES

Examples of stochastic processes - Poisson process Discrete time Markov chain models Definition and notation - Sojourn times in states - Examples of DTMCs in manufacturing - Chapman - Kolmogorov equation - Steady-state analysis. Continuous Time Markov Chain Models - Definitions and notation - Sojourn times in states - examples of CTMCs in manufacturing - Equations for CTMC evolution - Markov model of a transfer line. Birth and Death Processes in Manufacturing - Steady state analysis of BD Processes - Typical BD processes in manufacturing.

UNIT III QUEUING MODELS

Notation for queues - Examples of queues in manufacturing systems - Performance measures - Little's result - Steady state analysis of M/M/m queue, queues with general distributions and queues with breakdowns - Analysis of a flexible machine center.

UNIT IV QUEUING NETWORKS

Examples of QN models in manufacturing - Little's law in queuing networks - Tandem queue - An open queuing network with feed back - An open central server model for FMS - Closed transfer line - Closed server model - Garden Newell networks.

UNIT V PETRI NETS

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.

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.

313CCPT04 TRIBOLOGY IN DESIGN

OBJECTIVES:

To impart knowledge in the friction , wear and lubrication aspects of machine components
To understand the material properties which influence the tribological characteristics of surfaces.
To understand the analytical behavior of different types bearings and design of bearings based on analytical /theoretical approach

OUTCOME:

Ability to select material / surface properties based on the tribological requirements
Methodology for deciding lubricants and lubrication regimes for different operating conditions
Analysis ability of different types of bearings for given load/ speed conditions.

UNIT I SURFACE INTERACTION 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

UNIT II 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.

UNIT III 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**23** Hydrodynamic lubrication –– Elasto and plasto hydrodynamic - Magneto hydrodynamic lubrication – Hydro static lubrication – Gas lubrication.

UNIT IV 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

UNIT V 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.Stachowiak & A.W .Batchelor, Engineering Tribology, Butterworth-Heinemann,UK, 2005.

313CCPT05 METROLOGY AND NON DESTRUCTIVE TESTING

UNIT I MEASURING MACHINES

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

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

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 IV RADIO GRAPHY

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 V ULTRASONIC AND ACOUSTIC EMISSION TECHNIQUES

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.

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

313CCPT06 QUALITY MANAGEMENT TECHNIQUES

UNIT I INTRODUCTION
Need for TQM, evolution of quality, Definition of quality, TQM philosophy – CONTRIBUTIONS OF Deming Juran, Crosby and Ishikawa, TQM models.

UNIT II PLANNING
Vision, Mission, Quality policy and objective Planning and Organization for quality, Quality policy Deployment, Quality function deployment, introduction to BPR and analysis of Quality Costs.

UNIT III TQM PRINCIPLES
Customer focus, Leadership and Top management commitment, Employee involvement – Empowerment and Team work, Supplier Quality Management, Continuous process improvement, Training, performance Measurement and customer satisfaction.

UNIT IV TQM TOOLS AND TECHNIQUES
PDSA, The Seven Tools of Quality, New Seven management tools, Concept of six sigma, FMEA, Bench Marking, JIT, POKA YOKE, 5S, KAIZEN, Quality circles.

UNIT V QUALITY SYSTEMS
Need for ISO 9000 Systems, clauses Documentation, Implementation, Introduction to ISO14000 and OSHAS18000, Implementation of TQM, Case Studies.

TEXT BOOK:
1. Dale H.Besterfiled, "Total Quality Management", Pearson Education Asia, (Indian reprint 2002)

REFERENCES
1. Oakland.J.S. "Total Quality Management", Butterworth–Hcinemann Ltd., Oxford, 1989.
2. Narayana V. and Sreenivasan, N.S., "Quality Management – Concepts and Tasks", New Age International 1996.
3. Zeiri. "Total Quality Management for Engineers", Wood Head Publishers, 1991.
4. Juran J.M and Frank M.Gryna Jr., "Quality Planning and Analysis", TMH, India, 1982.
5. Brain Rethery, ISO 9000, Productivity and Quality Publishing Pvt.Ltd., 1993.
6. D.Mills, Quality Auditing, Chapman and Hall, 1993.

313CCPT07 DESIGN FOR CELLULAR MANUFACTURING SYSTEM

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

OBJECTIVES:
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
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
Problems in GT/CMS - Design of CMS - Models, traditional approaches and non-traditional approaches -Genetic Algorithms, Simulated Annealing, Neural networks.

UNIT III IMPLEMENTATION OF GT/CMS
Inter and Intra cell layout, cost and non-cost based models, establishing a team approach, Managerial structure and groups, batch sequencing and sizing, life cycle issues in GT/CMS.

UNIT IV PERFORMANCE MEASUREMENT AND CONTROL
Measuring CMS performance - Parametric analysis - PBC in GT/CMS, cell loading, GT and MRP - framework.

UNIT V ECONOMICS OF GT/CMS:
Conventional Vs group use of computer models in GT/CMS, Human aspects of GT/CMS - cases.

TEXT BOOKS:
1. Askin, R.G. and Vakharia, A.J., G.T " Planning and Operation, in The automated factory-Hand Book: Technology and Management ", Cleland.D.I. and Bidananda, B (Eds), TAB Books , NY, 1991.
2. Kamrani, A.K, Parsaei, H.R and Liles, D.H. (Eds), " Planning, design and analysis of cellular manufacturing systems ", Elsevier, 1995.

REFERENCES
1. Burbidge, J.L. Group " Technology in Engineering Industry ", Mechanical Engineering pub.London, 1979.
2. Irani, S.A. " Cellular Manufacturing Systems ", Hand Book.

Registrar