Annexure - M

S.A. ENGINEERING COLLEGE

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

Veeraraghavapuram, Thiruverkadu post, Chennai-600077

Curriculum and Syllabi

Master of Engineering
CAD/CAM

Regulation - 2020
Choice Based Credit System (CBCS)

The PG (M.E. CAD/CAM) Syllabus of the Department of Mechanical Engineering, S.A.Engineering College (Autonomous), Chennai for 2020-2021 admission onwards, has been ratified by the Board of Studies of Mechanical Engineering which met on 29.02.2020 at S.A. Engineering College, Chennai.

Contents

S.A ENGINEERING COLLEGE
(An Autonomous Institution)
M.E. CAD / CAM
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS (FULL TIME) CURRICULUM

SEMESTER I

SL. NO.	SUB CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MA2101	Applied Mathematics for Engineers	FC	4	3	0	0	3
2.	ME2101	Computer Applications in Design	PC	3	3	0	0	3
3.	ME2102	Computer Aided Tools for Manufacturing	PC	3	3	0	0	3
4.	ME2103	Competitive Manufacturing Systems	PC	3	3	0	0	3
5.	ME2104	Advanced Finite Element Analysis	PC	3	3	0	0	3
6.		Professional Elective I	PE	3	3	0	0	3
7.	ME2110	CAD Laboratory	PC	4	0	0	4	2
8.	ME2111	Advanced Analysis and Simulation Laboratory	PC	4	0	0	4	2
TOTAL				**27**	**19**	**0**	**8**	**22**

SEMESTER II

SL. NO	SUB CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	ME2201	Design for Manufacture, Assembly and Environments	PC	3	3	0	0	3
2.	ME2202	Additive Manufacturing and Tooling	PC	3	3	0	0	3
3.	ME2203	Mechanical Behavior of Materials	PC	3	3	0	0	3
4.	ME2204	Integrated Product Design and Process Development	PC	5	3	2	0	3
5.		Professional Elective II	PE	3	3	0	0	3
6.		Professional Elective III	PE	3	3	0	0	3
7.	ME2211	CAM Laboratory	PC	2	0	0	2	1
8.	ME2212	Design Project	EEC	4	0	0	4	2
TOTAL				**26**	**18**	**2**	**6**	**21**

SEMESTER III

SL. NO	SUB CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	ME2301	Product Lifecycle Management	PC	3	3	0	0	3
2.		Professional Elective IV	PE	3	3	0	0	3
3.		Professional Elective V	PE	3	3	0	0	3
PRACTICALS								
4.	ME2310	Project Work Phase I	EEC	12	0	0	12	6
			TOTAL	**21**	**9**	**0**	**12**	**15**

SEMESTER IV

SL. NO	SUB CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	ME2401	Project Work Phase II	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE: 70

LIST OF ELECTIVES FOR M.E. CAD / CAM

SEMESTER I (Elective I)

SL. NO.	SUB CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	ME2105	Computer Control in Process Planning	PE	3	3	0	0	3
2.	ME2106	Optimization Techniques in Design	PE	3	3	0	0	3
3.	ME2107	Advanced Mechanics of Materials	PE	3	3	0	0	3
4.	ME2108	Information Analytics	PE	3	3	0	0	3
5.	ME2109	Mechatronics Applications in Manufacturing	PE	3	3	0	0	3

SEMESTER II (Elective II & III)

SL. NO.	SUB CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	ME2205	Industrial Safety Management	PE	3	3	0	0	3
2.	ME2206	Advanced Tool Design	PE	3	3	0	0	3
3.	ME2207	Mechanisms Design and Simulation	PE	3	3	0	0	3
4.	ME2208	Computational Fluid Dynamics	PE	3	3	0	0	3
5.	ME2209	Reliability in Engineering Systems	PE	3	3	0	0	3
6.	ME2210	Integrated Mechanical Design	PE	3	3	0	0	3

SEMESTER III (Elective IV & V)

SL. NO.	SUB CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	ME2302	Performance Modeling and Analysis of Manufacturing System	PE	3	3	0	0	3
2.	ME2303	Metrology and Non Destructive Testing	PE	3	3	0	0	3
3.	ME2304	Quality Management Techniques	PE	3	3	0	0	3
4.	ME2305	Design for Cellular Manufacturing Systems	PE	3	3	0	0	3
5.	ME2306	Composite Materials and Mechanics	PE	3	3	0	0	3
6.	ME2307	Design of Material Handling Equipments	PE	3	3	0	0	3
7.	ME2308	Industrial Robotics and Expert Systems	PE	3	3	0	0	3
8.	ME2309	Design for Internet of Things	PE	3	3	0	0	3

MA 2101 **APPLIED MATHEMATICS FOR NGINEERS** **L T P C**

3 0 0 3

OBJECTIVES :

This course is designed to enrich the knowledge in various advanced mathematical techniques such as matrix theory, calculus of variations, probability and random variables, Laplace transforms and Fourier transforms. The fundamental concepts in these areas will be more useful for the students to model the engineering problems and solving them by applying these methods.

UNIT I MATRIX THEORY 12

The Cholesky decomposition - Generalized Eigenvectors - Canonical basis - QR factorization - Least squares method - Singular value decomposition.

UNIT II CALCULUS OF VARIATIONS 12

Concept of variation and its properties – Euler's equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – Isoperimetric problems - Direct methods : Ritz and Kantorovich methods.

UNIT III PROBABILITY AND RANDOM VARIABLES 12

Probability – Axioms of probability – Conditional probability – Baye's theorem - Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.

UNIT IV LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 12

Laplace transform - Definitions - Properties – Transform error function - Bessel's function - Dirac delta function - Unit step functions – Convolution theorem – Inverse Laplace transform : Complex inversion formula – Solutions to partial differential equations : Heat equation - Wave equation.

UNIT V FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 12

Fourier transform : Definitions - Properties – Transform of elementary functions - Dirac delta function – Convolution theorem – Parseval's identity – Solutions to partial differential equations : Heat equation - Wave equation - Laplace and Poison's equations.

TOTAL : 60 PERIODS

OUTCOMES :

After completing this course, students should demonstrate competency in the following skills:

- Apply various methods in matrix theory to solve system of linear equations.
- Maximizing and minimizing the functional that occur in various branches of engineering disciplines.
- Computation of probability and moments, standard distributions of discrete and continuous random variables and functions of a random variable.
- Application of Laplace and Fourier transforms to initial value, initial–boundary value and boundary value problems in Partial Differential Equations.

REFERENCES :

1. Andrews L.C. and Shivamoggi, B. "Integral Transforms for Engineers", Prentice Hall of India Pvt. Ltd., New Delhi, 2003.
2. Bronson, R. "Matrix Operations", Schaum's outline series, 2nd Edition, McGraw Hill, 2011.
3. James, G., "Advanced Modern Engineering Mathematics ", 3rd Edition, Pearson Education, 2004.
4. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
5. O'Neil, P.V., "Advanced Engineering Mathematics ", Thomson Asia Pvt. Ltd., Singapore, 2003.
6. Sankara Rao, K., "Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.

ME 2101 **COMPUTER APPLICATIONS IN DESIGN** **L T P C**
3 0 0 3

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

UNIT I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS 9
Output primitives (points, lines, curves etc.,), 2-D & 3-D transformation (Translation, scaling, rotation) windowing - view ports - clipping transformation.

UNIT II CURVES AND SURFACES MODELING 9
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 9
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 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 AND PRODUCT DATA EXCHANGE 9
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.

TOTAL : 45 PERIODS

OUTCOMES:
- 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 curve which is necessary to solve CAE problems that arise in engineering.

REFERENCES:

1. David F. Rogers, James Alan Adams "Mathematical elements for computer graphics" second edition, Tata McGraw-Hill edition.
2. Donald Hearn and M. Pauline Baker "Computer Graphics", Prentice Hall, Inc., 1992.
3. Foley, Wan Dam, Feiner and Hughes – Computer graphics principles & practices, Pearson Education – 2003.
4. Ibrahim Zeid Mastering CAD/CAM – McGraw Hill, International Edition, 2007.
5. William M Neumann and Robert F.Sproul "Principles of Computer Graphics", McGraw Hill Book Co. Singapore, 1989.

ME2102 COMPUTER AIDED TOOLS FOR MANUFACTURING

L	T	P	C
3	0	0	3

OBJECTIVE:

The purpose of this course is to make the students to get familiarized with various computer aided tools that can be implemented in various industrial applications

UNIT I COMPUTER AIDED MANUFACTURING 9

Manufacturing Processes – Removing, Forming, Deforming and joining – Integration equipments. Integrating CAD, NC and CAM – Machine tools – Point to point and continuous path machining, NC, CNC and DNC – NC Programming – Basics, Languages, G Code, M Code, APT – Tool path generation and verification – CAD/CAM NC Programming – Production Control – Cellular Manufacturing

UNIT II COMPUTER AIDED PROCESS PLANNING 9

Role of process planning in CAD/CAM Integration – Computer Aided Process Planning – Development, Benefits, Model and Architecture – CAPP Approaches – Variant, Generative and Hybrid – Process and Planning systems – CAM-I, D-CLASS and CMPP – Criteria in selecting a CAPP System.

UNIT III COMPUTER AIDED INSPECTION 9

Engineering Tolerances – Need for Tolerances – Conventional Tolerances – FITS and LIMITS – Tolerance Accumulation and Surface quality – Geometric Tolerances – Tolerances Practices in design, Drafting and manufacturing – Tolerance Analysis – Tolerance synthesis – Computer Aided Quality control – Contact Inspection Methods – Non Contact Inspection Methods - Non optical.

UNIT IV REVERSE ENGINEERING 9

Scope and tasks of Reverse Engineering – Domain Analysis – Process Duplicating – Tools for RE– Developing Technical data – Digitizing techniques – Construction of surface model – Solid part model – Characteristic evaluation – Software's and its application – CMM and its feature capturing - surface and solid modeling.

UNIT V DATA MANAGEMENT 9

Strategies for Reverse Engineering Data management – Software application – Finding renewable software components – Recycling real time embedded software – Design experiments to evaluate a RE tools – Rule based detection for RE user interface – RE of assembly programs

TOTAL: 45 PERIODS

OUTCOME:

- It helps the students to get familiarized with computer aided tools for various industrial applications which includes manufacturing, process planning, inspection, data management and reverse engineering.

REFERENCES

1. Catherine A. Ingle, "Reverse Engineering", Tata McGraw Hill Publication, 1994
2. David D. Bedworth, Mark R. Henderson, Philp M. Wolfe, "Computer Integrated Design and manufacturing", McGraw Hill International series, 1991
3. Donald R. Honra, "Co-ordinate measurement and reverse Engineering, American Gear Manufacturers Association.
4. Ibrahim Zeid and R. Sivasubramanian, "CAD/CAM Theory and Practice", Revised First special Indian Edition, Tata McGraw Hill Publication, 2007
5. Ibrahim Zeid, "Mastering CAD/CAM", special Indian Edition, Tata McGraw Hill Publication, 2007
6. Linda Wills, "Reverse Engineering" Kluwer Academic Press,1996

ME2103 **COMPETITIVE MANUFACTURING SYSTEMS** **L T P C**
3 0 0 3

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 ACOMPETITIVE 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 OFF MS 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

OUTCOME:
- To impart knowledge on the pace of changes in the manufacturing technology

REFERENCES

1. Groover M.P., "Automation, Production Systems and Computer Integrated Manufacturing ", Third Edition, Prentice-Hall, 2007.
2. Jha, N.K. “Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991.
3. Kalpkjian, “Manufacturing Engineering and Technology ", Addison-Wesley Publishing Co., 1995.
4. Pascal Dennis, “Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System”, (Second edition), Productivity Press, New York, 2007.
5. Taiichi Ohno, Toyota Production System Beyond Large-Scale Production, Productivity Press, 1988

ME2104 **ADVANCED FINITE ELEMENT ANALYSIS** **L T P C**
3 0 0 3

OBJECTIVE:
To develop a thorough understanding of the advanced finite element analysis techniques with an ability to effectively use the tools of the analysis for solving practical problems arising in engineering design

UNIT I BENDING OF PLATES AND SHELLS 9
Review of Elasticity Equations – Bending of Plates and Shells – Finite Element Formulation of Plate and Shell Elements - Conforming and Non-Conforming Elements – C0 and C1 Continuity Elements –Degenerated shell elements- Application and Examples.

UNIT II NON-LINEAR PROBLEMS 9
Introduction – Iterative Techniques – Material non-linearity – Elasto Plasticity – Plasticity – Visco Plasticity – Geometric Non linearity – large displacement Formulation –Solution procedure- Application in Metal Forming Process and Contact Problems.

UNIT III DYNAMIC PROBLEM 9
Direct Formulation – Free, Transient and Forced Response – Solution Procedures – Eigen solution-Subspace Iterative Technique – Response analysis-Houbolt, Wilson, Newmark –Methods

– Explicit &Implict Methods- Lanchzos, Reduced method for large size system equations.

UNIT IV FLUID MECHANICS AND HEAT TRANSFER 9
Governing Equations of Fluid Mechanics – Solid structure interaction - Inviscid and Incompressible Flow – Potential Formulations – Slow Non-Newtonian Flow – Metal and Polymer Forming – Navier Stokes Equation – Steady and Transient Solution.

UNIT V ERROR ESTIMATES AND ADAPTIVE REFINEMENT 9
Error norms and Convergence rates – h-refinement with adaptivity – Adaptive refinement.

TOTAL: 45 PERIODS

OUTCOMES:
- The students will understand the Finite Element Formulation of Plate and Shell Elements and its application.
- The students will be able to gain knowledge in material & geometric non-and plasticity.
- The students will be able to solve problems under dynamic conditions by applying various techniques.
- The students can arrive at the solutions for fluid mechanics and heat transfer problems.
- The students will acquire knowledge in error norms, convergence rates and refinement.
- The students will solve the real world engineering problems using FEA.

REFERENCES:

1. Bathe K.J., “Finite Element Procedures in Engineering Analysis”, Prentice Hall, 1990.
2. Cook R.D., “Concepts and Applications of Finite Element Analysis”, John Wiley and Sons Inc., New york, 1989.
3. Zienkiewicz, O.C. and Taylor, R.L., “The Finite Element Method”, Fourth Edition, Volumes 1 & 2, McGraw Hill International Edition, Physics Services,1991.

ME2110 **CAD LABORATORY**

L	T	P	C
0	0	4	2

OBJECTIVE:

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

- **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.
- **CAD data Exchange formats-** IGES, PDES, PARASOLID, DXF and STL

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

TOTAL: 60PERIODS

OUTCOME:

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

ME2111 ADVANCED ANALYSIS AND SIMULATION LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

To give exposure to software tools needed to analyze engineering problems.
To expose the students to different applications of simulation and analysis tools.

A. SIMULATION

1. MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables
2. Use of Matlab to solve simple problems in vibration
3. Mechanism Simulation using Multibody Dynamic software

B. ANALYSIS

1. Force and Stress analysis using link elements in Trusses, cables etc.
2. Stress and deflection analysis in beams with different support conditions.
3. Stress analysis of flat plates and simple shells.
4. Stress analysis of axi – symmetric components.
5. Thermal stress and heat transfer analysis of plates.
6. Thermal stress analysis of cylindrical shells.
7. Vibration analysis of spring-mass systems.
8. Model analysis of Beams.
9. Harmonic, transient and spectrum analysis of simple systems.

TOTAL: 60 PERIODS

OUTCOME:

- Upon completion of this course, the Students can model, analyse and simulate experiments to meet real world system and evaluate the performance.

ME2201 DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENTS L T P C
3 0 0 3

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

UNIT I INTRODUCTION 5
General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric tolerances - Assembly limits -Datum features - Tolerance stacks.

UNIT II FACTORS INFLUENCING FOR M DESIGN 13
Working principle, Material, Manufacture, Design- Possible solutions - Materials choice – Influence of materials on form design - form design of welded members, forgings and castings.

UNIT III COMPONENT DESIGN MACHINING CONSIDERATION 8
Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability – Design for accessibility - Design for assembly – Product design for manual assembly - Product design for automatic assembly – Robotic assembly.

UNIT IV COMPONENT DESIGN –CASTING CONSIDERATION 10
Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design Modifying the design - group technology - Computer Applications for DFMA

UNIT V DESIGN FOR THE ENVIRONMENT 9
Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT&T's environmentally responsible product assessment - Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly – Design for recyclability – Design for manufacture – Design for energy efficiency – Design to regulations and standards.

TOTAL: 45 PERIODS

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

REFERENCES:

1. Boothroyd, G, 1980 Design for Assembly Automation and Product Design. New York, Marcel Dekker.
2. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994.
3. Bralla, Design for Manufacture handbook, McGraw hill, 1999.
4. Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995.
5. Fixel, J. Design for the Environment McGraw Hill., 1996.
6. Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.
7. Harry Peck , Designing for manufacture, Pitman– 1973
8. Kevin Otto and Kristin Wood, Product Design. Pearson Publication, (Fourth Impression)2009.

ME 2202 **ADDITIVE MANUFACTURING AND TOOLING** **L T P C**
3 0 0 3

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

UNIT I INTRODUCTION: **9**
Need-DevelopmentofAMsystems–AMprocesschain-ImpactofAMonProductDevelopment- Virtual Prototyping-Rapid Tooling – RP to AM -Classification of AM processes-Benefits- Applications.

UNIT II REVERSE ENGINEERING AND CADMODELING: **9**
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 ADDITIVEMANUFACTURING SYSTEMS **9**
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 **9**
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 TOOLING **9**
Classification, Soft tooling, Production tooling, Bridge tooling, direct and indirect tooling, Fabrication processes, Applications Case studies automotive, aerospace and electronics industries

TOTAL: 45 PERIODS

OUTCOMES:
The students will be able to
- Understand history, concepts and terminology of additive manufacturing
- Apply the reverse engineering concepts for design development
- Understand the variety of additive manufacturing techniques
- Design and develop newer tooling models
- Analyse the cases relevant to mass customization and some of the important research challenges associated with AM and its data processing tools

REFERENCES:

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

ME 2203 MECHANICAL BEHAVIOR OF MATERIALS L T P C
3 0 0 3

OBJECTIVE:
To know the mechanical behavior of both metallic and non-metallic materials under different loading and temperature conditions.

UNIT I BASIC CONCEPTS OF MATERIAL BEHAVIOR 10
Elasticity in metals and polymers– Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviour – Super plasticity –. Griffith's theory,– Ductile, brittle transition in steel – High temperature fracture, creep – Larson Miller parameter-Deformation and fracture mechanism maps.

UNIT II BEHAVIOUR UNDER DYNAMIC LOADS AND DESIGN APPROACHES 10
Stress intensity factor and fracture toughness – Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law.- Safe life, Stress life, strain-life and fail - safe design approaches -Effect of surface and metallurgical parameters on fatigue – Fracture of non metallic materials – Failure analysis, sources of failure, procedure of failure analysis.

UNIT III SELECTION OF MATERIALS 10
Motivation for selection, cost basis and service requirements – Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications – Computer aided materials selection.

UNIT IV MODERN METALLIC MATERIALS 8
Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel – Intermetallics, Ni and Ti aluminides – smart materials, shape memory alloys – Metallic glass and nano crystalline materials.

UNIT V NON METALLIC MATERIALS 7
Polymeric materials – Formation of polymer structure – Production techniques of fibers, foams, adhesives and coating – structure, properties and applications of engineering polymers – Advanced structural ceramics, WC, TIC, TaC, Al2O3, SiC, Si3N4 CBN and diamond – properties, processing and applications.

TOTAL : 45 PERIODS

OUTCOME:
- To familiarize the researchers in the area of material behavior under different loading and selection of materials for the design of engineering structures.

REFERENCES:

1. Ashby M.F., materials selection in Mechanical Design 2nd Edition, Butter worth 1999.
2. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., Selection and use of engineering materials, (34d edition), Butterworth-Heiremann, 1997.
3. Flinn, R.A., and Trojan, P.K., Engineering Materials and their Applications, (4th Edition) Jaico, 1999.
4. George E.Dieter, Mechanical Metallurgy, McGraw Hill, 1988
5. Metals Hand book, Vol.10, Failure Analysis and Prevention, (10th Edition), Jaico, 1999.
6. Thomas H. Courtney, Mechanical Behavior of Materials, (2nd edition), McGraw Hill,2000

ME 2204 INTEGRATED PRODUCT DESIGN AND PROCESS DEVELOPMENT L T P C
3 2 0 3

OBJECTIVE

The course aims at providing the basic concepts of product design, product features and its architecture so that student can have a basic knowledge in the common features a product has and how to incorporate them suitably in product.

UNIT I INTRODUCTION 8

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 10

Plan and establish product specifications. Task - Structured approaches - clarification - search- externally 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 8

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 8

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 11

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

TOTAL: 75 PERIODS

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

OUTCOMES:

On completion of the course the student will be able to

- Understand the integration of customer requirements in product design
- Apply structural approach to concept generation, selection andtesting
- Understand various aspects of design such as industrial design , design for manufacture , economic analysis and product architecture

REFERENCES:

1. Concurrent Engg./Integrated Product Development. Kemnneth Crow, DRM Associates, 6/3, ViaOlivera, 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. Product Design and Development, Karl T.Ulrich and Steven D.Eppinger, McGraw –Hill International Edns.1999
4. Tool Design – Integrated Methods for successful Product Engineering, Stuart Pugh, Addison Wesley Publishing,Neyourk,NY,1991, ISBN 0-202-41639-5
5. www.me.mit/2.7444

ME 2211 **CAM LABORATORY** **L T P C**
0 0 2 1

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 : 1

TOTAL: 30PERIODS

ME 2212 **DESIGN PROJECT** **L T P C**
0 0 4 2

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.

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.

OUTCOME:

- It helps the students to get familiarized with respect to design standards, design calculations and analysis in designing any mechanical component orsystem.

TOTAL: 60PERIODS

ME 2105 COMPUTER CONTROL IN PROCESS PLANNING L T P C
3 0 0 3

OBJECTIVE

To provide the student with an understanding of the importance of process planning role in manufacturing and the application of Computer Aided Process Planning tool in the present manufacturing scenario

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 modeling 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, **Al.**

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

OUTCOMES:

- Have a sound knowledge in process planning
- Handle computer aided process planning tool

REFERENCES

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

WEB REFERENCES:

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

ME 2106 **OPTIMIZATION TECHNIQUES IN DESIGN** **L T P C**
3 0 0 3

OBJECTIVE:

To impart knowledge on various categories of existing engineering problems and solutions to such problems through different optimization techniques and approaches.

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

OUTCOME:

- It helps the students to get familiarized with the different approaches of optimizing (maximizing or minimizing) an engineering problem or a function.

REFERENCES

1. Goldberg, D.E., “Genetic algorithms in search, optimization and machine”, Barnen, Addison- Wesley, New York, 1989.
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. Rao, Singaresu, S., “Engineering Optimization – Theory & Practice”, New Age International (P) Limited, New Delhi, 2000.

ME 2107 **ADVANCED MECHANICS OF MATERIALS** **L T P C**
3 0 0 3

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

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 STRESSES IN FLAT PLATES AND CURVED MEMBERS **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 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.

TOTAL : 45 PERIODS

OUTCOME:
It helps the students to be familiarized with the stresses under different loadingconditions.

REFERENCES:

1.Allan F. Bower, “Applied Mechanics of Solids”, CRC press – Special Indian Edition -2012, 2010
2.Arthur P Boresi, Richard J. Schmidt, “Advanced mechanics of materials”,John Wiley, 2002.
3.G H Ryder Strength of Materials Macmillan, India Ltd, 2007.
4.K. Baskar and T.K. Varadan, “Theory of Isotropic/Orthotropic Elasticity”, Ane Books Pvt. Ltd., New Delhi, 2009
5.Robert D. Cook, Warren C. Young, "Advanced Mechanics of Materials", Mc-millan pub. Co., 1985.
6.Srinath. L.S., “Advanced Mechanics of solids”, Tata McGraw Hill, 1992.
7.Timoshenko and Goodier, "Theory of Elasticity", McGraw Hill.

ME 2108 **INFORMATION ANALYTICS** **L T P C**
3 0 0 3

OBJECTIVE:
To expose the students with fundamental concepts and the tools needed to understand emerging role of information analytics in the organisation.

UNIT– I DATA ANALYTICS LIFE CYCLE 9
Introduction to Big data Business Analytics - State of the practice in analytics role of data scientists - Key roles for successful analytic project - Main phases of life cycle - Developing core deliverables forstake holders.

UNIT– II STATISTICS 9
Sampling Techniques - Data classification, Tabulation, Frequency and Graphic representation - Measures of central value - Arithmetic mean, Geometric mean, Harmonic mean, Mode, Median, Quartiles, Deciles, Percentile - Measures of variation – Range, IQR, Quartile deviation, Mean deviation, standard deviation, coefficient variance, skewness, Moments & Kurtosis.

UNIT–III PROBABILITY AND HYPOTHESIS TESTING 9
Random variable, distributions, two dimensional R.V, joint probability function, marginal density function. Random vectors - Some special probability distribution - Binomial, Poison, Geometric, uniform, exponential, normal, gamma and Erlang. Multivariate normal distribution - Sampling distribution – Estimation - point, confidence - Test of significance, 1& 2 tailed test, uses of t distribution, F-distribution, χ 2distribution.

UNIT– IV PREDICTIVE ANALYTICS 9
Predictive modeling and Analysis - Regression Analysis, Multicollinearity, Correlation analysis, Rank correlation coefficient, Multiple correlation, Least square, Curve fitting and good ness of fit.

UNIT– V TIME SERIES FORECASTING AND DESIGN OF EXPERIMENTS 9
Forecasting Models for Time series: MA, SES, TS with trend, season - Design of Experiments, one way classification, two way classification, ANOVA, Latin square, Factorial Design.

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of the course, the students will be able to
- Understand the importance of data analysis in the design of new products.
- Carry out statistical analysis.
- Do probability analysis and hypothesis testing.
- Perform predictive analysis.
- Learn the effect of forecasting methods and to apply for business process.
- Build a reliable, scalable, distributed information system.

REFERENCES:

1. Alberto Cordoba, “Understanding the Predictive Analytics Lifecycle”, Wiley, 2014.
2. Chris Eaton, Dirk Deroos,Tom Deutsch et al.,“Understanding Big Data”,McGrawHIll, 2012.
3. James R Evans, “Business Analytics – Methods, Models and Decisions”, Pearson 2013.
4. R. N. Prasad, SeemaAcharya, “Fundamentals of Business Analytics”, Wiley, 2015.
5. S M Ross, “Introduction to Probability and Statistics for Engineers and Scientists”, Academic Foundation, 2011.

ME 2109 MECHATRONICS APPLICATIONS IN MANUFACTURING L T P C
3 0 0 3

OBJECTIVES:

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

UNIT I INTRODUCTION 9

Introduction to Mechatronics - Systems - 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

OUTCOMES:

Upon completion of this course, the Students can able to design mechatronics system with the help of Microprocessor, PLC and other electrical and Electronics Circuits.

REFERENCES:

1. Bradley, D.A., Dawson, D, Buru, N.C. and Loader, AJ, "Mechatronics ", Chapman and Hall, 1993
2. Ghosh, P.K. and Sridhar, P.R., 0000 to 8085, “Introduction to Microprocessors for Engineers and Scientists ", Second Edition, Prentice Hall, 1995
3. Lawrence J.Kamm, " Understanding Electro-Mechanical Engineering, An Introduction to Mechatronics ", Prentice-Hall, 2000.
4. Michael B.Histand and David G. Alciatore, " Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, 1999.
5. Ramesh.S, Gaonkar, "Microprocessor Architecture, Programming and Applications” Wiley Eastern, 1998.

ME 2205 **INDUSTRIAL SAFETY MANAGEMENT** **L T P C**
3 0 0 3

OBJECTIVES:

To achieve an understanding of principles of safety management.
To enable the students to learn about various functions and activities of safety department.
To enable students to conduct safety audit and write audit reports effectively in auditing situations.
To have knowledge about sources of information for safety promotion and training.
To familiarize students with evaluation of safety performance.

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

OUTCOMES:

- To understand the functions and activities of safety engineering department.
- To carry out a safety audit and prepare a report for the audit.
- To prepare an accident investigation report.
- To estimate the accident cost using supervisors report and data.
- To evaluate the safety performance of an organization from accident records.
- To identify various agencies, support institutions and government organizations involved in safety training and promotion.

REFERENCES:

1. Industrial safety and the law by P.M.C. Nair Publisher's, Trivandrum.
2. John V. Grimaldi and Rollin H. Simonds, "Safety Management", All India Travellers bookseller, New Delhi-1989.
3. Krishnan N.V., "Safety in Industry", Jaico Publisher House, 1996
4. Managing emergencies in industries, Loss Prevention of India Ltd., Proceedings,1999.
5. Occupational Safety Manual BHEL.
6. Safety security and risk management by U.K. Singh & J.M. Dewan, A.P.H. Publishing company, New Delhi, 1996.
7. Singh, U.K. and Dewan, J.M., "Safety, Security and risk management", APH Publishing Company, New Delhi, 1996.

ME 2206 **ADVANCEDTOOLDESIGN** **L T P C**
3 0 0 3

OBJECTIVES:
The purpose of this course is to make the students to get familiarized with the design of various tools that can be implemented for different mechanical operations

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

OUTCOME:
- It helps the students to get familiarized with advanced tool design for various mechanical operations which includes cutting, jigs and fixtures, press tool dies and modern CNC machinetools.

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. Haslehurst M., “Manufacturing Technology”, The ELBS, 1978
4. PrakashHiralal Joshi, “Tooling data”, Wheeler Publishing, 2000
5. Venkataraman K., “Design of Jigs, Fixtures and Press tools”, TMH, 2005

ME 2207 MECHANISMS DESIGN AND SIMULATION L T P C
3 0 0 3

OBJECTIVE:
To develop a thorough understanding of the various mechanisms and its design and simulation with an ability to effectively use the various mechanisms in real life problems.

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 - Harten berg 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-cuspcrunode coupler driven six-bar mechanisms-straight line mechanisms

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

TOTAL : 45 PERIODS

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

OUTCOME:
- It helps the students to get familiarized with the advanced mechanisms which are necessary to design and simulate mechanisms.

REFERENCES:

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

ME 2208 **COMPUTATIONAL FLUID DYNAMICS** **L T P C**
3 0 0 3

OBJECTIVES

This course aims to introduce numerical modeling and its role in the field of heat, fluid flow and combustion 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.
To develop finite volume discretized forms of the CFD equations.
To formulate explicit & implicit algorithms for solving the Euler Equations &Navier Strokes Equations.

UNIT I GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION TECHNIQUES 8

Basics of Heat Transfer, Fluid flow – Mathematical description of fluid flow and heat transfer – Conservation of mass, momentum, energy and chemical species - Classification of partial differential equations – Initial and Boundary Conditions – Discretisation techniques using finite difference methods – Taylor's Series - Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT II DIFFUSION PROCESSES : FINITE VOLUME METHOD 10

Steady one-dimensional diffusion, Two and three dimensional steady state diffusion problems, Discretisation of unsteady diffusion problems – Explicit, Implicit and Crank- Nicholson's schemes, Stability of schemes.

UNIT III CONVECTION - DIFFUSION PROCESSES : FINITE VOLUME METHOD 9

One dimensional convection – diffusion problem, Central difference scheme, upwind scheme – Hybrid and power law discretization techniques – QUICK scheme.

UNIT IV FLOW PROCESSES : FINITE VOLUME METHOD 8

Discretisation of incompressible flow equations – Pressure based algorithms, SIMPLE, SIMPLER & PISO algorithms

UNIT V MODELING OF COMBUSTION AND TURBULENCE 10

Mechanisms of combustion and Chemical Kinetics, Overall reactions and intermediate reactions, Reaction rate, Governing equations for combusting flows. Simple Chemical Reacting System (SCRS), Turbulence - Algebraic Models, One equation model & k – – ω k models - Standard and High and Low Reynolds number models.

TOTAL: 45 PERIODS

OUTCOME:

- On successful completion of this course the student will be able to apply the concepts of CFD to analyse the fluid flow and heat transfer in thermalsystems.

REFERENCES:

1. Ghoshdastidar, P.S., "Computer Simulation of Flow and Heat Transfer", Tata McGraw-Hill Publishing Company Limited, New Delhi, 1998.
2. JiyuanTu, Guan HengYeoh, Chaogun Liu, "Computational Fluid Dynamics A Practical Approach" Butterworth – Heinemann An Imprint of Elsevier, Madison, U.S.A., 2008
3. John D. Anderson . JR. "Computational Fluid Dynamics The Basics with Applications" McGraw- Hill International Editions, 1995.
4. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.
5. Subas and V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation,1980.
6. Versteeg and Malalasekera, N, "An Introduction to computational Fluid Dynamics The Finite Volume Method," Pearson Education, Ltd., Second Edition, 2014.

ME 2209 **RELIABILITY IN ENGINEERING SYSTEMS** **L T P C**
3 0 0 3

OBJECTIVES

The ability to use statistical tools to characterise the reliability of an item;
The working knowledge to determine the reliability of a system and suggest approaches to enhancing system reliability;
The ability to select appropriate reliability validation methods

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 – Softwarere liability.

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

OUTCOMES:

- Analyse the interference between strength and stress, or life data for estimating reliability;
- Apply the appropriate methodologies and tools for enhancing the inherent and actual reliability of components and systems, taking into consideration cost aspects; specify life test plans for reliability validation

REFERENCES

1. Charles E. Ebeling, "An introduction to Reliability and Maintainability engineering", TMH, 2000.
2. Roy BillingtonandRonaldN.Allan,"ReliabilityEvaluationofEngineeringSystems",Springer, 2007.

ME 2210 **INTEGRATED MECHANICAL DESIGN** **L T P C**
(Use of Approved Data Book is permitted) **3 0 0 3**

OBJECTIVE:
To know the integrated design procedure of different machine elements for mechanical applications.

UNIT I FUNDAMENTALS AND DESIGN OF SHAFTS 9
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 9
Principlesofgeartoothaction–Gearcorrection–Geartoothfailuremodes–Stressesandloads - 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 & CLUTCHES 9
Dynamics and thermal aspects of brakes and clutches – Integrated design of brakes and clutches for machine tools, automobiles and mechanical handling equipments.

UNIT IV INTEGRATED DESIGN 18
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

TOTAL: 45 PERIODS

The Pattern of Question Paper will consist of one Question from Unit – 4 for 50% of total marks.
**** a Term Project must be given for Assessment – 3 (Compulsory)**

OUTCOME:
- This will familiarize the students with the concepts of integration of design of machines and structures.

REFERENCES:

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

APPROVED DATA BOOKS

1. P.S.G. Tech., “Design Data Book”, KalaikathirAchchagam, Coimbatore, 2003.
2. Lingaiah. K. and NarayanaIyengar, “Machine Design Data Hand Book”, Vol. 1 & 2, Suma Publishers, Bangalore,19.