MUTHAYAMMAL ENGINEERING COLLEGE

An Autonomous Institution

(Approved by AICTE | Accredited by NBA & NAAC | Affiliated to Anna University)
Rasipuram - 637 408, Namakkal Dist., Tamil Nadu.

Curriculum/Syllabus

Programme Code : ME

Programme Name : M.E-CAD/CAM

Regulations : 2023

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Rasipuram - 637 408, Namakkal Dist., Tamil Nadu.

Ph. No.: 04287-220837
Email: info@mec.ac.in

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Estd. 2000

Institution Vision & Mission

Institution Vision

- To be a Centre of Excellence in Engineering, Technology and Management on par with International Standards.

Institution Mission

- To prepare the students with high professional skills and ethical values.
- To impart knowledge through best practices.
- To instill a spirit of innovation through Training, Research and Development.
- To undertake continuous assessment and remedial measures.
- To achieve academic excellence through intellectual, emotional and social stimulation.

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Department Vision & Mission

Department Vision

- To prepare competent Mechanical Engineers with state of art technologies to cater industry demands

Department Mission

- To create technically proficient students to meet global challenges
- To enable the opportunities for students and faculty members to apply the knowledge
- To prepare students to excel as successful professionals and entrepreneur's in their careers

Program Educational Objectives

PEO1 : Graduates should be able to Comprehend, analyze and synthesize data in order to design and develop mechanical systems

PEO2 : Graduates should be able to resolve industrial problems and create newer opportunities

PEO3 : Graduates should be able to demonstrate leadership skills and ethical value for sustainable economical development towards the improvement of quality of life

Program Specific Outcomes

PSO1 : To apply the knowledge of design, development and analysis of Mechanical Systems

PSO2 : To demonstrate collaborative learning for making more sustainable products

PSO3 : To work as a professional entrepreneur by applying Mechanical and Management practices

Program Outcomes

PO1 : **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 : **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and Engineering sciences.

PO3 : **Design/Development solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 : **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 : **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 : **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 : **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

PO8 : **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 : **Individual and team work:** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 : **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 : **Project management and finance:** Demonstrate knowledge and understanding of the engineering management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 : **Lifelong learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

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M.E.- CAD/CAM

Grouping of Courses

I. Foundation Course (FC)

Sl.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
1.	23CAF01	Advanced Numerical Methods	FC	4	3	1	0	4
2.	23CAF02	Applied Mathematics	FC	4	3	1	0	4
3.	23CAF03	Applied Probability and Statistics	FC	4	3	1	0	4
4.	23CAF04	Design of Experiments and Research Methodology	FC	3	3	0	0	3

II. Professional Core (PC)

1.	23CAC01	Computer Aided Design	PC	3	3	0	0	3
2.	23CAC02	Competitive Manufacturing Systems	PC	3	3	0	0	3
3.	23CAC03	Design for Manufacture and Assembly	PC	3	3	0	0	3
4.	23CAC04	CNC Machines and Robotics	PC	3	3	0	0	3
5.	23CAC05	Advanced Strength of Materials	PC	3	2	1	0	3
6.	23CAC06	Finite Element Analysis and Applications	PC	3	3	0	0	3
7.	23CAC07	Integrated Product and Process Development	PC	3	3	0	0	3
8.	23CAC08	Industrial Safety Management	PC	3	3	0	0	3
9.	23CAC09	Applied Materials Engineering	PC	3	3	0	0	3
10.	23CAC10	Computational Fluid Dynamics	PC	3	2	1	0	3
11.	23CAC11	Data communications in CAD/CAM	PC	3	3	0	0	3
12.	23CAC12	Mechanisms Design and Simulation	PC	3	3	0	0	3
13.	23CAP01	Computer Aided Design Laboratory	PC	3	0	0	3	1
14.	23CAP02	CNC Machines and Robotics Laboratory	PC	3	0	0	3	1
15.	23CAP03	Finite Element Analysis and Applications Laboratory	PC	3	0	0	3	1

III. Professional Elective (PE)

1.	23CAE01	Optimization Techniques in Design	PE	3	2	1	0	3
2.	23CAE02	Advanced Tool Design	PE	3	2	1	0	3
3.	23CAE03	Computer Control in Process Planning	PE	3	2	1	0	3
4.	23CAE04	Reliability in Engineering Systems	PE	3	2	1	0	3
5.	23CAE05	Tribology in Composite Materials Design	PE	3	2	1	0	3
6.	23CAE06	Design of Material Handling Equipment's	PE	3	3	0	0	3
7.	23CAE07	Mechatronics Applications in Manufacturing	PE	3	3	0	0	3
8.	23CAE08	Modeling and Analysis of Manufacturing Systems	PE	3	3	0	0	3
9.	23CAE09	Productivity Management and Re-Engineering	PE	3	3	0	0	3
10.	23CAE10	Design and Manufacturing of Composite Materials	PE	3	3	0	0	3
11.	23CAE11	Integrated Mechanical Design	PE	3	3	0	0	3
12.	23CAE12	Additive Manufacturing	PE	3	3	0	0	3
13.	23CAE13	Geometric Modeling	PE	3	3	0	0	3
14.	23CAE14	Corrosion Engineering	PE	3	3	0	0	3
15.	23CAE15	Nano Materials and Technology	PE	3	3	0	0	3

IV. Employability Enhancement Courses (EEC)

1.	23CAM01	Project Work Phase -I	EEC	12	0	0	12	6
2.	23CAM02	Project work Phase -II	EEC	24	0	0	24	12
3.	23CAM03	Seminar	EEC	3	0	0	3	1
4.	23CAM04	Design & Analysis Project	EEC	3	0	0	3	1

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M.E.- CAD/CAM
Curriculum | PG - R2023
Semester -I

Sl.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
Theory								
1.	23CAF04	Design of Experiments and Research Methodology		3	3	0	0	3
2.	23CAC01	Computer Aided Design		3	3	0	0	3
3.	23CAC02	Competitive Manufacturing Systems		3	3	0	0	3
4.	23CAC03	Design for Manufacture and Assembly		3	3	0	0	3
5.	23CAC04	CNC Machines and Robotics		3	3	0	0	3
6.	23CAC09	Applied Materials Engineering		3	3	0	0	3
Practical								
7.	23CAP01	Computer Aided Design Laboratory		3	0	0	3	1
8.	23CAP02	CNC Machines and Robotics Laboratory		3	0	0	3	1
							Total Credit	**20**

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Semester -II

Sl.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
Theory								
1.	23CAC06	Finite Element Analysis and Applications		3	3	0	0	3
2.	23CAC07	Integrated Product and Process Development		3	3	0	0	3
3.	23CAC05	Advanced Strength of Materials		3	3	0	0	3
4.	23CAE**	Elective I		3	2	1	0	3
5.	23CAE**	Elective II		3	3	0	0	3
Practical								
6.	23CAP03	Finite Element Analysis and Applications Laboratory		3	0	0	3	1
7.	23CAM03	Seminar		3	0	0	3	1
8.	23CAM04	Design & Analysis Project		3	0	0	3	1
							Total Credit	**18**

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M.E.- CAD/CAM
Curriculum | PG - R2023
Semester -III

Sl.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
Theory								
1.	23CAE**	Elective III		3	2	1	0	3
2.	23CAE**	Elective IV		3	3	0	0	3
3.	23CAE**	Elective V		3	3	0	0	3
Practical								
4.	23CAM01	Project Work Phase I		12	0	0	12	6
							Total Credit	**15**

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M.E.- CAD/CAM
Curriculum | PG - R2023

Semester –IV

Sl.No	Course Code	CourseTitle	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
Practical								
1.	23CAM02	Project Work Phase II		12	0	0	24	12
							Total Credit	**12**

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M.E.- CAD/CAM
Curriculum | PG - R2023

Summary of Course Component

Sl.No.	Course Area	Semesters				Total Credits
		I	II	III	IV	
1.	FC	3	-	-	-	**3**
2.	PC	17	10	-	-	**27**
3.	PE	-	6	9	-	**15**
4.	SDC	-	2	6	12	**20**
Total		**20**	**18**	**15**	**12**	**65**

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FOUNDATION COURSE

(FC)

For

CAD/CAM

23CAF01	ADVANCED NUMERICAL METHODS	L	T	P	C
		3	1	0	4

Course Objective:

- To learn the algebraic equations which finds applications in many engineering branches
- To make the student acquire sound knowledge of computational techniques in solving ordinary differential equations that model engineering.
- To solve Elliptic equations by using computational techniques
- To introduce numerical tools for the solutions of partial differential equations that model several physical processes
- To deal with interpolation and approximation for the application of finite element analysis
- To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in engineering and technology.

Course Outcomes:

23CAF01.CO1	Demonstrate understanding and implementation of numerical solution algorithms applied to solve algebraic equations
23CAF01.CO2	Be familiar with numerical solutions of ordinary differential equation and partial differential equations.
23CAF01.CO3	Be competent with finite difference method and finite element method.
23CAF01.CO4	Understanding the theoretical and practical aspects of the use of numerical methods. Implementing numerical methods for a variety of multidisciplinary applications. Establishing the limitations, advantages, and disadvantages of numerical methods
23CAF01.CO5	The students will have a clear perception of the power of numerical Techniques. This will also serve as a precursor for future research.
23CAF01.CO6	Students would be able to demonstrate the applications of numerical techniques to problems drawn from industry, management and other engineering fields.

Unit-I ALGEBRAIC EQUATIONS 12

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, Eigen value problems: power method, inverse power method, Faddeev – Leverrier Method.

Unit-II ORDINARY DIFFERENTIAL EQUATIONS 12

RungeKutta Meth ods for system of IVPs, numerical stability, Adams - Bashforth multistep method, solution of stiff ODEs, shooting method, BVP: Finite difference method, orthogonal collocation method, orthogonal collocation with finite element method, galerkin finite element method.

Unit-III FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATIONS 12

Parabolic equations: explicit and implicit finite difference methods, weighted average approximation - Dirichlet and Neumann conditions – Two dimensional parabolic equations – ADI method; First order hyperbolic equations – method of characteristics, different explicit and implicit methods; numerical stability analysis, method of lines – Wave equation: Explicit scheme - Stability of above schemes.

Unit-IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS 12

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.

Unit-V FINITE ELEMENT METHOD 12

Partial differential equations – Finite element method – orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.

Total Periods: 60

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	M.K. Jain , S.R.K. Iyengar,R.K. Jain	Computational Methods for Partial Differential Equations, 2nd Edition	New Age Publishers	2016
2.	S. K. Gupta	Numerical Methods for Engineers, 3rd Edition	New Age International Pvt Ltd Publishers	2015
3.	SaumyenGuha and Rajesh Srivastava	Numerical methods for Engineering and Science	Oxford Higher Education, New Delhi	2010
4.	M.K. Jain	Numerical Methods for Scientific & Engineering Computation, 6th Edition	New Age International Publishers	2010
5.	Burden, R.L., and Faires, J.D.	Numerical Analysis – Theory and Applications	Cengage Learning, India Edition, New Delhi	2009

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23CAF02	APPLIED MATHEMATICS	L	T	P	C
		3	1	0	3

Course Objective:

- To realize the use of matrix theory techniques in engineering applications and to develop for future applications.
- To analyze and solve the fundamental problem with prescribed or free boundary conditions in simple cases
- Demonstrate knowledge of mathematics and mechanics to construct, analyze and interpret real world problems
- Provide a foundation and motivation for exposure to statistical ideas subsequent to the course.
- To formulate and construct a mathematical model for a linear programming problem in real life situation
- To introduce Fourier series analysis which is central to many applications in engineering
- To realize the use of matrix theory techniques in engineering applications and to develop for future applications.

Course Outcomes:

23CAF02.CO1	Explain geometrical concepts related to orthogonality and least squares solutions and perform calculations related to orthogonality.
23CAF02.CO2	The variation calculus makes access to mastering in a wide range of classical results of variation calculus. Students get up apply results in technical problem solutions
23CAF02.CO3	The students will have a basic knowledge of the main fields of mathematics and mechanics, including differential equations, elasticity theory, fluid mechanics.
23CAF02.CO4	The students will have an exposure of various distribution functions and help in acquiring skills in handling situations involving more than one variable
23CAF02.CO5	The knowledge gained on this course helps the students to do engineering optimization.
23CAF02.CO6	Demonstrate an understanding of the basic concepts of Fourier series analysis

Unit-I MATRIX THEORY **12**

The Cholesky decomposition - Generalized Eigen vectors, 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 – Functional dependant on functions of several independent variables – Variational problems with moving boundaries – problems with constraints - Direct methods: Ritz and Kantorovich methods.

Unit-III ONE DIMENSIONAL RANDOM VARIABLES **12**

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 LINEAR PROGRAMMING **12**

Formulation – Graphical solution – Simplex method – Two phase method - Transportation and Assignment Models

Unit-V FOURIER SERIES AND EIGEN VALUE PROBLEMS **12**

Fourier Trigonometric series: Periodic function as power signals – Convergence of series – Even and odd function: cosine and sine series – Non-periodic function: Extension to other intervals - Power signals: Exponential Fourier series – Parseval's theorem and power spectrum – Eigen value problems and orthogonal functions – Regular Sturm-Liouville systems – Generalized Fourier series.

Total Periods: 60

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Mital.K.V. Mohan and Chander	Optimization Methods in Operations Research and Systems Analysis, 4th Edition	New Age International Publishers	2016
2.	Stark. H., and Woods. J.W.	Probability and Random Processes with Applications to Signal Processing, 4th Edition	Pearson Education, Asia	2014
3.	HamdyATaha	Operations Research, 9th Edition (Asia)	Pearson Education, Asia	2014
4.	Gupta, A.S.	Calculus of Variations with Applications	Prentice Hall of India Pvt. Ltd., New Delhi	2011
5.	Richard Bronson	Matrix Operation, Schaum's outline series, 2nd Edition	McGraw Hill	2011

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23CAF03	APPLIED PROBABILITY AND STATISTICS	L	T	P	C
		3	1	0	4

Course Objective:

- To introduce the basic concepts of one dimensional and two dimensional Random Variables.
- To gain knowledge in the application of family of random variables in real life situations
- To provide information about Correlation and Regression
- Learn about maximum likelihood estimation, unbiased estimation and least square methods.
- To understand concepts of testing of hypothesis
- To enable the students to use the concepts of multivariate normal distribution and principle components analysis
- To introduce the basic concepts of one dimensional and two dimensional Random Variables.

Course Outcomes:

23CAF03.CO1	Analyze random or unpredictable experiments and investigate important features of random experiments. Construct probabilistic models for observed phenomena through distributions which play an important role in many engineering applications.
23CAF03.CO2	Associate random variables by designing joint distributions and correlate the random variables
23CAF03.CO3	Perform and interpret correlation and regression analysis and develop correlation models to predict changes in processes and products for linear and non-linear relationships
23CAF03.CO4	Provides knowledge to apply testing of hypothesis to real life problems.
23CAF03.CO5	Be familiar with multivariate analysis.
23CAF03.CO6	The student will able to acquire the basic concepts of Probability and Statistical techniques for solving mathematical problems which will be useful in solving Engineering problems.

Unit-I ONE DIMENSIONAL RANDOM VARIABLES 12

Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Functions of a Random Variable.

Unit-II TWO DIMENSIONAL RANDOM VARIABLES 12

Joint distributions – Marginal and Conditional distributions – Functions of two dimensional random variables – Regression Curve – Correlation.

Unit-III ESTIMATION THEORY 12

Unbiased Estimators – Method of Moments – Maximum Likelihood Estimation - Curve fitting by Principle of least squares – Regression Lines.

Unit-IV TESTING OF HYPOTHESES 12

Sampling distributions - Type I and Type II errors - Tests based on Normal, t, Chi-Square and F distributions for testing of mean, variance and proportions – Tests for Independence of attributes and Goodness of fit.

Unit-V MULTI VARIATE ANALYSIS 12

Random Vectors and Matrices - Mean vectors and Covariance matrices - Multivariate Normal density and its properties - Principal components Population principal components – Principal components from standardized variables.

Total Periods: 60

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Douglas C. Montgomery, George C. Runger	Applied Statistics and Probability for Engineers (International Student Version), 6th Edition	John Wiley & Sons, Inc.	2016
2.	Richard A. Johnson and Dean W. Wichern,	Applied Multivariate Statistical Analysis, 6th Edition	Pearson Education, Asia	2015
3.	Gupta S.C. and Kapoor V.K	Fundamentals of Mathematical Statistics	Sultan Chand & Sons	2014
4.	HweiP.Hsu,	Schaum‟s Outline of Theoryand Problems of Probability, Random Variables and RandomProcesses	Tata McGraw Hill Edition, New Delhi	2014
5.	Walpole. R.E., Myers.R.H., Myers.S.L., and Ye. K.,,	Probability and Statisticsfor Engineers and Scientists, 8thEdition	Pearson Education, Asia	2013

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		L	T	P	C
23CAF04	**DESIGN OF EXPERIMENTS AND RESEARCH METHODOLOGY**	**3**	**0**	**0**	**3**

Course Objective:

- To introduce different research methods
- To understand different testing methods of hypotheses
- To understand the terminology in design of experiments
- To illustrate the interaction between different input data
- To familiarize the statistical approach in experimental data analysis
- To design different experimental design

Course Outcomes:

23CAF04.CO1	Understand the fundamentals of research methodology.
23CAF04.CO2	Illustrate the different testing methods in research
23CAF04.CO3	Develop different design of experiments
23CAF04.CO4	Comprehend the interaction between input data
23CAF04.CO5	Identify and construct various statistical approach
23CAF04.CO6	Construct experimental design and provide recommendation

Unit-I INTRODUCTION OF RESEARCH METHODOLOGY **12**

Research methodology - definition, mathematical tools for analysis, Types of research, exploratory research, conclusive research, modeling research, algorithmic research, Research process- steps. Data collection methods

Unit-II TESTING METHODS **12**

Hypotheses testing - Testing of hypotheses concerning means (one mean and difference between two means -one tailed and two tailed tests), concerning variance - one tailed Chi-square test.

Unit-III DESIGN OF EXPERIMENTS **12**

Special Terminology - Design of Experiments, Response variable, Measured output value , Factors-Input variables that can be changed, Levels -Specific values of factors (inputs),Continuous or discrete, Replication-Completely re-run experiment with same input levels -Used to determine impact of measurement error, Interaction-Effect of one input factor depends on level of another input factor.

Unit-IV STATISTICAL APPROACH **12**

Design of Experiments (DOE) -A statistics-based approach to design experiments , A methodology to achieve a predictive knowledge of a complex, multi-variable process with the fewest acceptable trials, An optimization of the experimental process itself, Major Approaches to DOE -Factorial Design, Taguchi Method and Response Surface Design.

Unit-V INTRODUCTION AND OVERVIEW OF EXPERIMENTAL DESIGN **12**

Introduction and Overview of Experimental Design - The seven essential components of designing - Choosing the response (i.e. the dependent variable to be measured), Choosing the factors and levels(i.e. the independent variables and their values),Choosing experimental plan, Conduct the experiment, Analyze the data , Draw conclusions and make recommendations.

Total Periods: 60

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	C.R.Kothari, GauravGarg	Research methods and techniques	3rd edition, new age international publications	2014
2.	Montgomery, Douglas C	Design and Analysis of Experiments" (International Student Version)	8th edition, John Wiley & Sons	2012
3.	Douglas C. Montgomery, George C. Runger	Applied Statistics and Probability for Engineers (International Student Version)	6th Edition, John Wiley & Sons, Inc	2016
4.	Montgomery, Douglas C., Runger, George C. and Hubele, Norma F.	Engineering Statistics	5th edition, John Wiley & Sons	2012
5.	Jeffrey A. GlinerGeorge A. Morgan, and Nancy L.Leech	Research methods in applied settings: an integrated approach to design and analysis	Taylor & Francis	2016

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PROFESSIONAL CORE

(PC)

For

CAD/CAM

23CAC01	COMPUTER AIDED DESIGN	L	T	P	C
		3	0	0	3

Course Objective:

- To impart the fundamental theory of the computer graphics.
- To understand the computer application and design for curves and surface modeling.
- To familiarize the basic fundamental of NURBS and solid modeling.
- To understand the algorithms of shading, coloring in visual realism.
- To impart knowledge on the various aspects of modeling of assembly parts.
- To understand the various analyses in product data exchange
- To impart the fundamental theory of the computer graphics.

Course Outcomes:

23CAC01.CO1	Explain the primitives in computer graphics, 2D and 3Dtransformations
23CAC01.CO2	Explain different types of curves in surface modeling
23CAC01.CO3	Discuss the various types of curves in solid modeling.
23CAC01.CO4	Explain the algorithms and principles of creation of prismatic and lofted parts
23CAC01.CO5	Examine the mechanism involved in assembly modeling.
23CAC01.CO6	Understand and analysis the product data exchange.

Unit-I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS 12

Primitives (points, lines, curves etc.,), 2-D & 3-D transformation (Translation, scaling, rotators) windowing - view ports - clipping transformation.

Unit-II CURVES AND SURFACES MODELLING 12

Introduction to curves - Analytical curves: line, circle and conics - synthetic curves - Hermit 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 - Hermit bi cubic surface- Bezier surface and B-Spline surface- surface manipulations.

Unit-III NURBS AND SOLID MODELING 12

NURBS – Basics- curves, lines, arcs, circle and bi linear surface - primitive instancing - sweep representations -boundary representations - constructive solid Geometry - comparison of representations - user interface for solid modeling.

Unit-IV VISUAL REALISM 12

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 12

Assembly modeling - interferences of positions and orientation - tolerances analysis - mass property calculations - mechanism simulation - Graphics and computing standards - IGES, STEP etc- Communication standards

Total Periods: 60

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	John F. Hughes, Andries van Dam, Morgan McGuire, David F. Sklar, James D. Foley, Steven K. Feiner, Kurt Akeley	Computer Graphics: Principles and Practice	Addison-Wesley Professional; 3rd edition	2013
2.	Donald Hearn and M. Pauline Baker	Computer Graphics	Prentice Hall, Inc	2016
3.	Ibrahim Zeid	Mastering CAD/CAM	McGraw-Hill, Inc	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	2010

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23CAC02	COMPETITIVE MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

Course Objective:

- To emphasize the knowledge on quality improvement and automation
- To know how to create highest caliber products quickly and inexpensively.
- To know the principles of flexible manufacturing systems.
- To understand the modern methods required for manufacturing competitive environment.
- To comprehend the necessity of customer focused manufacturing.
- To understand the factors to consider for the quality manufacturing.
- To emphasize the knowledge on quality improvement and automation

Course Outcomes:

23CAC02.CO1	Understand the principles of manufacturing in a competitive environment.
23CAC02.CO2	Understand and explain group technology and flexible manufacturing
23CAC02.CO3	Explain the hierarchy of computer control
23CAC02.CO4	Explainthesoftwarerequiredforsimulationanddatabaseforflexiblemanufacturing systems.
23CAC02.CO5	Understand and explain the principles and methods of lean manufacturing.
23CAC02.CO6	Explain the elements involved in Just in time process.

Unit-I MANUFACTURING IN A COMPETITIVE ENVIRONMENT **12**

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 **12**

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 DATA BASE OF FMS **12**

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 **12**

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 **12**

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

Total Periods: 60

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Pascal Dennis	Lean Production Simplified: A Plain-Language Guide to the World's MostPowerful Production System	Second edition, Productivity Press, New York	2016
2.	Groover M.P	Automation, Production Systems and Computer Integrated Manufacturing	Third Edition, Prentice-Hall	2014
3.	Jha, N.K	Handbook of Flexible Manufacturing Systems	Academic Press Inc	2012
4.	Wilson	How to Implement Lean Manufacturing	McGraw-Hill Publishing Company	2015
5.	Allen N. Mendl	Just in Time	Solution Tree	2005

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23CAC03	DESIGN OF MANUFACTURE AND ASSEMBLY	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the selection of materials, methods, fits and tolerance concepts to design a Product.
- To familiarize the basic concept of design for castings, forming and machining.
- To understand the factors influencing the manufacturing processes.
- To comprehend the factors influencing the designing of cast and machined components.
- To understand the basic procedure of design for assembly and environments.
- To familiarize the tools required in various manufacturing processes.

Course Outcomes:

23CAC03.CO1	Understand the basic principles for manufacturability.
23CAC03.CO2	Understand and explain the factors influencing the form design systems
23CAC03.CO3	Demonstrate the design considerations required for machined components
23CAC03.CO4	Comprehend and explain the design consideration for cast components.
23CAC03.CO5	Demonstrate the need for designing for environment
23CAC03.CO6	Explain life cycle assessment.

Unit-I BASICS OF DESIGNING PRINCIPLES 12

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 SYSTEMS 12

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 12

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 12

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 12

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

Total Periods: 60

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Kevien Otto and Kristin Wood	Product Design	Pearson Publication	2011
2.	Boothroyd, G, Heartz and Nike	Product Design for Manufacture	Marcel Dekker	2010
3.	A. K. Chitale and R. C. Gupta	Product Design and Manufacturing	Prentice Hall Inc	2007
4.	Fixel, J	Design for the Environment	McGraw hill	1996
5.	Dickson, John. R, and Corroda Poly	Engineering Design and Design for Manufacture and Structural Approach	Field Stone Publisher, USA.	1995

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23CAC04	CNC MACHINES AND ROBOTICS	L	T	P	C
		3	0	0	3

Course Objective:

- To familiarize in the field of automated machines like computer numerical control and robotics.
- To understand the construction principles of CNC machines.
- To comprehend and explain the elements of control systems in CNC machines
- To understand and develop a computer numerical control program for lathe and milling machine.
- To be able to write programs for robot motion.
- To understand the anatomy of robots and its applications.
- To familiarize in the field of automated machines like computer numerical control and robotics.

Course Outcomes:

23CAC04.CO1	Understand and explain the CNC lathe and milling machines
23CAC04.CO2	Identify and explain the types of feedback and control systems in CNC machines
23CAC04.CO3	Construct and experiment various part programming of CNC lathe and milling
23CAC04.CO4	Apply and practice basic principles of robotic design.
23CAC04.CO5	Understand and write programs for various robot motion controls.
23CAC04.CO6	Understand and explain robot working principles for various applications.

Unit-I CONSTRUCTIONAL FEATURES OF CNC MACHINES **12**

CNC Machines - Concept, Classifications, working principle, advantages and limitation - Constructional features - Machine structure – Friction and Antifriction LM guide ways - Recirculating ball bearings, Linear motion bearings - Feed and spindle drives - Tool turret - Tool changer - ATC, APC - Chip conveyors.

Unit-II FEEDBACK AND CONTROL SYSTEMS **12**

Open loop and closed loop systems - Interpolator - Feedback devices - Digital absolute and incremental measuring system - Incremental rotary encoder, Moiré fringes and absolute rotary encoders - Configuration of CNC system and Interfacing.

Unit-III PART PROGRAMMING OF CNC LATHE AND MILLING **12**

Tooling - Preset, semi-qualified and qualified tooling - Absolute and incremental programming – G and M codes for Lathe and Milling machine - CNC Lathe - Single and multi-pass canned cycle programming - Turning, profile turning, grooving, threading and drilling cycle programming - Tool offset - Tool nose radius compensation CNC Milling - Profile and pocket milling, drilling, boring cycle programming - Cutter diameter compensation CNC Lathe - Single and multi-pass canned cycle programming - Turning, profile turning, grooving, threading and drilling cycle programming - Tool offset - Tool nose radius compensation CNC Milling - Profile and pocket milling, drilling, boring cycle programming - Cutter diameter compensation

Unit-IV FUNDAMENTAL CONCEPT OF ROBOTICS **12**

History, Robot Anatomy - work volume - drive system - Control system and Dynamic performance - End effector, Gripper - Mechanical, hydraulic and Pneumatic gripper and Tool as end effector - Robotic sensor, Tactile and Proximity sensors - Robot applications in material handling system, processing and its assembly.

Unit-V ROBOT MOTION CONTROL AND PROGRAMMING **12**

Introduction to manipulator kinematics - Homogeneous co-ordinates and Homogeneous transformations for the manipulator - Manipulator path control, motion types - Robot dynamics - Methods of robot programming - Lead through and Robot programming languages - Simple commands in VAL- Working and configurations of five axis CNC machines - Latest CNC tool materials - Applications of robots in automotive industry

Total Periods: 60

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	PM Agarwal and VJ Patel	CNC Fundamentals and Programming	Charotar Publishing House	2014
2.	P Radhakrishnan	Computer Numerical Control CNC machines	New central book agency	2013
3.	A. K. Chitale and R. C. Gupta	Mechatronics	Tata McGraw Hill Publications	2009
4.	Mikell P Groover, Mitchell weiss, Roger N Nagel G Odrey	Industrial Robotics	TATA Mc-Graw Hill	2012
5.	KhushdeepGoyal	CNC Machines and Automation	S.K. Kataria& Sons	2014

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23CAC05	ADVANCED STRENGTH OF MATERIALS	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the basic concepts of stress, strain, displacement and transformations
- To be able to estimate strength and predict failure of materials
- To able to find the shear stress and shear strain centre.
- To understand and use energy methods to find force, stress and displacement in simple structures.
- To understand stresses in open and closed sections in torsion and bending
- To understand stress functions, and understand stresses in plates and shells, thick circular cylinders and discs, contact stresses and stress concentration.

Course Outcomes:

23CAC05.CO1	Understand the basic concepts of elasticity and stress strain relationship
23CAC05.CO2	Locate the shear centre and understand the shear flows for various sections.
23CAC05.CO3	Solve stress related problems in curved flexible members and plates
23CAC05.CO4	Examine the torsion forces in non- circular sections
23CAC05.CO5	Analyze the stress in rotating members
23CAC05.CO6	Analyze the contact stresses and explain the methods of computing them.

Unit-I ELASTICITY **12**

Stress - Strain relations and equilibrium equations of elasticity in Cartesian, Polar and Spherical coordinates-Differential equations of equilibrium-Compatibility-Boundary conditions -Airy's stress - Representation of three-dimensional stress of a tension-Generalized Hook's law.

Unit-II SHEAR CENTRE AND UNSYMMETRICAL BENDING **12**

Location of shear center for various sections - Shear flows - Stresses and deflections in beams subjected to unsymmetrical loading - Kern of a section.

Unit-III CURVED FLEXIBLE MEMBERS AND STRESSES IN PLATES **12**

Circumference and radial stresses - Deflections-Curved beam with restrained ends-Closed ring subjected to concentrated load and uniform load-Chain links and crane hooks-Stresses in circular and rectangular plates due to various types of loading and end conditions.

Unit-IV TORSION OF NON-CIRCULAR SECTIONS **12**

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 MEMBER AND CONTACT STRESSES **12**

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

Total Periods: 60

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Allan F. Bower	Applied Mechanics of Solids	CRC press – Special Indian Edition -2012	2010
2.	Srinath. L.S	Advanced Mechanics of solids	Tata McGraw Hill	2009
3.	K. Baskarand T.K.Varadan	Theory of Isotropic/Orthotropic Elasticity	Ane Books Pvt. Ltd	2009
4.	Boresi, Arthur P. and Schmidt Richard J	Advanced Mechanics of Materials	6th Ed,." John Wiley - Sons	2003
5.	G H Ryder	Strength of Materials	Macmillan, India Ltd	2007

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23CAC06	FINITE ELEMENT ANALYSIS AND APPLICATIONS	L	T	P	C
		3	0	0	3

Course Objective:

- To obtain an understanding of the fundamental theory of the FEA method.
- To understand the application and use of the FE method for heat transfer problems.
- To understand the use of the basic finite elements for structural applications using truss, beam, frame, and plane elements.
- To be able to use the basic finite elements for structural applications using plane stress, plane strain problems.
- To understand the overview of application packages such as ANSYS and DEFORM.
- To be able to develop code for one dimensional analysis and validation.

Course Outcomes:

23CAC06.CO1	Apply the procedure involved to solve a structural problem using Finite Element Methods.
23CAC06.CO2	Develop the element stiffness matrices using different approach.
23CAC06.CO3	Develop the global and natural co-ordinates, shape functions for one and two dimensional elements
23CAC06.CO4	Analyze a 2D problem using line, triangular, Axisymmetry, quadrilateral element, Tetrahedral and hexahedral elements.
23CAC06.CO5	Develop FEA/FEM general pre and post processing solutions.
23CAC06.CO6	Develop code for one dimensional analysis and validation.

Unit-I INTRODUCTION **12**

Basics of FEM - Initial value and boundary value problems - weighted residual Galerkin and Raleigh Ritz methods-review of Variational calculus-Integration by parts-Basics of Variation formulation

Unit-II ONE DIMENSIONAL ANALYSIS **12**

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 **12**

Global and Natural Co-ordinates - Shape functions for one and two dimensional elements - Three Noded triangular and four Noded quadrilateral element - Nonlinear analysis -Isoparametric elements - Basics of two dimensional axis symmetric analyses

Unit-IV TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS **12**

Equations of elasticity - Plane stress, plane strain and Axisymmetry problems - Body forces and temperature effects - Stress calculations - Plate and shell elements.

Unit-V COMPUTER IMPLEMENTATION **12**

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

Total Periods: 60

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	S. S. Rao	The Finite Element Method in Engineering	Elsevier Publishers,	2014
2.	D. L .Logan	A First Course in the Finite Element Method	Cengage Learning	2012
3.	S. S. Bhavikati	Finite Element Analysis	New Age International Publishers	2010
4.	Seshu, P	Text Book of Finite Element Analysis	Prentice-Hall of India Pvt. Ltd., New Delhi	2010
5.	Reddy. J.N	An Introduction to the Finite Element Method	3rd Edition, Tata McGraw-Hill	2009

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23CAC07	INTEGRATED PRODUCT AND PROCESS DEVELOPMENT	L	T	P	C
		3	0	0	3

Course Objective:

- To emphasize the need for integrated product development process
- To understand the significance of customer role in product development
- To be able to generate concepts and test them.
- To know to design for industry requirement and establish the best architecture
- To understand the factors influencing the product development.
- To understand the basics and need of prototyping.

Course Outcomes:

23CAC07.CO1	Understand the basic principles of product development
23CAC07.CO2	Identify and demonstrate the concept generation, selection and testing process
23CAC07.CO3	Demonstrate the establishment of product architecture
23CAC07.CO4	Apply various tools in industrial design process
23CAC07.CO5	Explain the elements involved in design for manufacturability.
23CAC07.CO6	Explain the principles involved in prototyping.

Unit-I BASIC CONCEPTS OFP RODUCT DEVELOPMENT **12**

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.

Unit-II CONCEPT GENERATION, SELECTION AND TESTING **12**

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 **12**

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 **12**

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 **12**

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 Periods: 60

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Karl T.Ulrich and Steven D.Eppinger	Product Design and Development	McGraw –Hill International Edns	2012
2.	G. Dieter and L. Schmidt	Engineering Design	4th ed., McGraw-Hill	2009
3.	K Otto and K Wood	Product Design	Pearson Publication	2008
4.	Stuart Pugh	Tool Design– Integrated Methods for successful Product Engineering	Addison Wesley Publishing,	2005
5.	S Rosenthal	Effective Product Design and Development	Business One Orwin, Homewood	2004

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23CAC08	INDUSTRIAL SAFETY MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the modern safety concepts.
- To be able to understand the role of employee in safety measures
- To provide a structured management approach to control safety risks in various operations.
- To be able to integrate health & safety measures into all tasks.
- To understand the techniques involved in accident prevention
- To know safety, health, welfare and laws.

Course Outcomes:

23CAC08.CO1	Explain the modern safety concepts and safety management functions.
23CAC08.CO2	Acquire, articulate and apply specialized knowledge relevant to operational safety.
23CAC08.CO3	Demonstrate the safety measures in various types of working places.
23CAC08.CO4	Explain the causes and costs of accidents
23CAC08.CO5	Illustrate the methods of accident prevention.
23CAC08.CO6	Comprehend various laws and welfare activities related to safety and health.

Unit-I SAFETY MANAGEMENT **12**

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 OPERATIONALSAFETY **12**

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

Unit-III SAFETYMEASURES **12**

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

Unit-IV A**CCIDENTPREVENTION** **12**

Human side of safety - personal protective equipment - Causes and cost of accidents -Accident prevention programmer - Specific hazard control strategies - HAZOP - Training and development.

Unit-V SAFETY, HEALTH, WELFARE& LAWS **12**

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 Periods: 60

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	BHEL	Occupational Safety Manual BHEL.	BHEL	2014
2.	Singh U.K. and Dewan J.M.,	Safety, Security and risk management",	APH Publishing Company, New Delhi,	1996.
3.	Krishnan N.V	Safety in Industry	Jaico Publisher House,	1996
4.	P M C Nair	Industrial safety and the law : an introduction	Attam Publishers, Thiruvananthapuram	1994
5.	John V. Grimaldi and Rollin H. Simonds	Safety Management	All India Travellers bookseller, New Delhi	1989

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23CAC09	APPLIED MATERIALS ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

- To provide the knowledge about the behaviors and various strengthening mechanisms of materials.
- To impart knowledge on fracture mechanism and failure analysis of materials.
- To provide the knowledge on material properties, material cost and factors to be considered while selecting materials for various applications.
- To study various cases in material selection for different applications.
- To educate the material processing concepts and various process induced defects.
- To familiarize the modern materials and heat treatment of materials.
- To provide the knowledge about the behaviors and various strengthening mechanisms of materials.

Course Outcomes:

23CAC09.CO1	Familiarize the fundamentals of material behavior
23CAC09.CO2	Explain the various strengthening mechanisms of materials
23CAC09.CO3	Comprehend fracture mechanism and discover the material failure defects
23CAC09.CO4	Select the suitable material for different applications
23CAC09.CO5	Propose the suitable process for materials and analyze the process induced defects
23CAC09.CO6	Explain the characteristics of modern materials

Unit-I ELASTIC AND PLASTIC BEHAVIOUR **12**

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

Unit-II FRACTURE BEHAVIOUR **12**

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 nonmetallic materials - Failure analysis, sources of failure, procedure of failure analysis.

Unit-III SELECTION OF MATERIALS **12**

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 **12**

Processing of engineering materials - Primary and Secondary processes -stability, Weldability, forge ability and malleability Criteria - Process induced defects - Monitoring and control.

Unit-V MODERN MATERIALS AND TREATMENT **12**

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, Al_2O_3, SiC, Si_3N_4, CBN, diamond – Plasma, PVD, CVD-thick and thin film deposition – Functionally Gradient Materials , Nanomaterials.

Total Periods: 60

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Norman E. Dowling	Mechanical Behaviour of Materials	McGraw-Hill	2012
2.	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
3.	Dieter, G.E	Mechanical Metallurgy	McGraw Hill	1988
4.	R.A.Flinn and P.K.Trojan	Engineering Materials and their Applications	Wiley	2006
5.	James, K.W., Wiley, Intersam, John	The Hand book of Advance Materials	Wilson Publishers.	2004

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		L	T	P	C
23CAC10	**COMPUTATIONAL FLUID DYNAMICS**	**2**	**1**	**0**	**3**

Course Objective:

- To emphasize the knowledge on boundary conditions, finite difference method, and numerical errors
- To understand the analysis of heat conduction in one dimensional and two dimensional method
- To understand the Governing equations and Boundary layer flow for Incompressible fluid
- To understand the basic concepts of one dimensional and two dimensional convection problems.
- To understand the basics of analysis by FEM
- To understand the algebraic models and heat transfer using standard codes

Course Outcomes:

23CAC10.CO1	Understand the principles of governing differential equation and finite difference method.
23CAC10.CO2	Understand and explain heat conduction in various dimensional method
23CAC10.CO3	Explain the equations for Incompressible fluid flow by difference approach.
23CAC10.CO4	Understand and explain the principles of convection heat transfer
23CAC10.CO5	Explain the FEM analysis of conduction and incompressible flow
23CAC10.CO6	Explain the fundamentals involved in turbulence models

Unit-I GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD 9

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 9

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

Unit-III INCOMPRESSIBLE FLUID FLOW 9

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 TRANSFERAND FEM 9

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 9

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.

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Jiri Blazek	Fluid Dynamics Applications	Butterworth-Heinemann	2015
2.	John Wendt	Computational Fluid Dynamics: An Introduction	Springer Science & Business Media	2013
3.	Wei Shyy, HS.Udaykumar, Madhukar M.Rao	Fluid Dynamics Boundaries	Courier Corporation	2012
4.	Ryoichi Amano, Sundén	Fluid Dynamics Emerging Topics	WIT Press	2011
5.	Eduardo Ramos S	Fluid Dynamics of Edition	Springer Science & Business Media	2011

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23CAC11	DATA COMMUNICATIONS IN CAD/CAM	L	T	P	C
		3	0	0	3

Course Objective:

- To provide the knowledge on basic functions, operations and languages of digital computers and microprocessors
- To impart knowledge on operating systems.
- To familiarize the functions of compiler.
- To provide the knowledge on data communication, networking, transmissions of communications systems
- To educate the different types of networking structure.
- To familiarize the Internet services and Protocols

Course Outcomes:

23CAC11.CO1	Explain the basic functions, operations and languages of digital computers and microprocessors
23CAC11.CO2	Describe various operating systems.
23CAC11.CO3	Describe the functioning of a compiler.
23CAC11.CO4	Illustrate various networking and communication models
23CAC11.CO5	Choose suitable network structure
23CAC11.CO6	Explain the internet services and Protocols

Unit-I DIGITAL COMPUTERS & MICRO PROCESSORS 9

Block diagram - register transfer language - arithmetic, logic and shift micro operations - instruction code - training and control instruction cycle - I/O and interrupt design of basic computer. Machine language-assembly language–assembler. Registers ALU and Bus Systems-timing and control signals - machine cycle and timing diagram - functional block diagrams of 80 x 86 and modes of operation - Features of Pentium Processors

Unit-II OPERATING SYSTEM & ENVIRONMENTS 9

Types - functions - UNIX & WINDOWS NT - Architecture - Graphical User Interfaces -Compilers - Analysis of the Source program - the phases of a compiler - cousins of the compiler, the grouping of phases - compiler construction tools.

Unit-III COMMUNICATION MODEL 9

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

Unit-IV COMPUTER NETWORKS 9

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

Unit-V INTERNET 9

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

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	William Stallings	Data of Computer Communications	Prentice Hall of India	2013
2.	Alfred V. Aho, Ravi Setjhi, Jeffrey D Ullman	Compilers Principles Techniques and Tools	Addison Wesley	2011
3.	Gaonkar R.S	Microprocessor Architecture, Programming and Applications of 8085	Penram International	2014
4.	Andrew S. Tanenbanum	Computer Networks	Prentice Hall of India 3rdEdition	2012
5.	Morris Mano. M	Computer System Architecture",	Prentice Hall of India	2013

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23CAC12	MECHANISMS DESIGN AND SIMULATION	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the layout of linkages and kinematic analysis of various links.
- To impart the knowledge of kinematics simulations of various mechanisms.
- To learn the Path Curvature Theory used in mechanisms.
- To study the synthesis analysis of four bar mechanisms.
- To comprehend synthesis of cam mechanisms
- To understand coupler curve based mechanisms.

Course Outcomes:

23CAC12.CO1	Comprehend the basics of mechanism design
23CAC12.CO2	Determine and analyze the kinematics attributes of various links.
23CAC12.CO3	Illustrate the path curvature theory and its applications
23CAC12.CO4	Design four bar based mechanisms of real time applications.
23CAC12.CO5	Analyze the cam mechanisms of real time applications
23CAC12.CO6	Describe the coupler curve based mechanisms

Unit-I INTRODUCTION 9

Introduction to kinematics and mechanisms-Mobility analysis-Formation of one degree of freedom Multi loop kinematic chains-Grass motion concepts-compliant and 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 links-Analytical and Graphical methods-displacement, velocity and acceleration analysis of simple mechanisms.

Unit-III PATH CURVATURE THEORY 9

Fixed and moving centrodes-Inflection points and inflection circle-Euler Savary equation- Bobillier's construction-Hartmann's construction-cubic of stationary curvature.

Unit-IV SYNTHESIS OF FOUR BAR MECHANISMS 9

Type and number synthesis- linkage concept-Dimensional synthesis-Function generation, path generation and motion generation-Graphical methods-Pole technique and inversion technique-Point position reduction-two, three and four position synthesis of four bar mechanisms-Analytical methods- Freuden stein's equation-Bloch's synthesis

Unit-V SYNTHESIS OF CAM AND COUPLER CURVE BASED MECHANISMS 9

Cognate linkages-parallel motion linkages-design of six bar, Single dwell, double dwell and double stroke-multi dwell -CAM mechanisms - determination of optimum size of cams- mechanism defects – Case Study-Kinematic analysis of spatial mechanisms – simulation mechanisms using software package.

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Kenneth J. Waldron, Gary L. Kinzel,Sunil K. Agrawal	Kinematics, Dynamics, and Design of Machinery	3rd Edition, John Wiley-Sons	2016
2.	David H. Myszka,	Machines & Mechanisms: Applied Kinematic Analysis	Pearson Education, 4th revised edition	2011
3.	J. J. Uicker, G. R. Pennock and J.E. Shigley	Theory of Machines and Mechanisms	Oxford University Press, NY, IInd Edition	2014
4.	Robert L. Nortron	Kinematics and Design of Machinery	McGraw Hill Higher Education, 2nd revised edition	2012
5.	A. Hernandez	Kinematic analysis of mechanisms via a velocity equation based in a geometric matrix	Mechanism and machine theory, vol. 38(12), pp 1413-1429	2013

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23CAP01	COMPUTER AIDED DESIGN LABORATORY	L	T	P	C
		0	0	3	1

Course Objective:

- To impart the fundamental theory of the computer graphics.
- To understand the computer application and design for curves and surface modeling.
- To familiarize the basic fundamental of NURBS and solid modeling.
- To understand the algorithms of shading, coloring in visual realism.
- To impart knowledge on the various aspects of modeling of assembly parts.
- To understand the various analyses in product data exchange

Course Outcomes:

23CAP01.CO1	Explain the primitives in computer graphics, 2D and 3Dtransformations
23CAP01.CO2	Explain different types of curves in surface modeling
23CAP01.CO3	Discuss the various types of curves in solid modeling.
23CAP01.CO4	Explain the algorithms and principles of creation of prismatic and lofted parts
23CAP01.CO5	Examine the mechanism involved in assembly modeling.
23CAP01.CO6	Understand and analysis the product data exchange.

Sl.No.	List of Experiments

Design

1. Sketcher
2. Solid modeling
3. Surface modeling
4. Feature manipulation
5. Assembly
6. Drafting

Analysis of mechanical components

7. Machine elements under Static loads
8. Thermal Analysis of mechanical systems
9. Modal Analysis
10. Machine elements under Dynamic loads
11. Non-linear systems

Total Periods: 45

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23CAP02	CNC MACHINES AND ROBOTICS LABORATORY	L	T	P	C
		0	0	3	1

Course Objective:

- To familiarize in the field of automated machines like computer numerical control and robotics.
- To understand the construction principles of CNC machines.
- To comprehend and explain the elements of control systems in CNC machines
- To understand and develop a computer numerical control program for lathe and milling machine.
- To be able to write programs for robot motion.
- To understand the anatomy of robots and its applications.

Course Outcomes:

23CAP02.CO1	Understand and explain the CNC lathe and milling machines
23CAP02.CO2	Identify and explain the types of feedback and control systems in CNC machines
23CAP02.CO3	Construct and experiment various part programming of CNC lathe and milling
23CAP02.CO4	Apply and practice basic principles of robotic design.
23CAP02.CO5	Understand and write programs for various robot motion controls.
23CAP02.CO6	Understand and explain robot working principles for various applications.

Sl.No. **List of Experiments**

Design

1. Simulation and Machining using CNC / DNC Machine Tools using FEM Packages, Relational Data Base, Networking.
2. Practice on Computer Aided Measuring Instruments.
3. Image Processing.
4. Software Development for Manufacturing.
5. Use of advanced CNC Machining Packages.
6. Business Data Processing

Total Periods: 45

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23CAP03	FINITE ELEMENT ANALYSIS AND APPLICATIONS LABORATORY	L	T	P	C
		0	0	3	1

Course Objective:

- To obtain an understanding of the fundamental theory of the FEA method.
- To understand the application and use of the FE method for heat transfer problems.
- To understand the use of the basic finite elements for structural applications using truss, beam, frame, and plane elements.
- To be able to use the basic finite elements for structural applications using plane stress, plane strain problems.
- To understand the overview of application packages such as ANSYS and DEFORM.
- To be a able to develop code for one dimensional analysis and validation.

Course Outcomes:

23CAP03.CO1	Apply the procedure involved to solve a structural problem using Finite Element Methods.
23CAP03.CO2	Develop the element stiffness matrices using different approach.
23CAP03.CO3	Develop the global and natural co-ordinates, shape functions for one and two dimensional elements
23CAP03.CO4	Analyze a 2D problem using line, triangular, Axisymmetry, quadrilateral element, Tetrahedral and hexa hedral elements.
23CAP03.CO5	Develop FEA/FEM general pre and post processing solutions.
23CAP03.CO6	Develop code for one dimensional analysis and validation.

Sl.No.	List of Experiments
1.	Assembly modeling of various parts of the clamping device
2.	Assembly modeling of various parts of the center lathe.
3.	Assembly modeling of piston, gudgeon pin and the crank shaft of IC engines
4.	Assembly modeling of various parts of a Fixture
5.	Assembly modeling of various parts of the shaper
6.	Surface modeling a piston of an I.C. engine.
7.	Assembly modeling and simulation of a valve operating mechanism of internal combustion engine.
8.	Assembly modeling and simulation of a Mechanism of Hand Pump.
9.	Assembly modeling and simulation of a Mechanism of wiper.
10.	Assembly modeling and simulation of a transmission system used in automobiles

Total Periods: 45

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PROFESSIONAL ELECTIVES

(PE)

For

CAD/CAM

23CAE01	OPTIMIZATION TECHNIQUES IN DESIGN	L	T	P	C
		2	1	0	3

Course Objective:

- To acquire concepts of design optimization, and model the engineering problem mathematically.
- To impart knowledge on various optimization methods for obtaining approximate structural design solutions.
- To impart knowledge on single and multi-variable optimization techniques.
- To solve problems on design of experiments.
- To familiarize the selecting algorithms for solving multi-objective and non-traditional optimization problems.

Course Outcomes:

23CAE01.CO1	Understand the principles of optimization in design.
23CAE01.CO2	Analyze and solve using single variable optimization techniques.
23CAE01.CO3	Analyze and solve using multi variable and constrained optimization techniques.
23CAE01.CO4	Select proper design of experiments and modeling.
23CAE01.CO5	Solve problems on design of experiments and modeling
23CAE01.CO6	Solve the engineering problems using suitable non-traditional optimization techniques.

Unit-I INTRODUCTION 9

Introduction to optimum design - Principles of optimization - Conventional versus Optimal design process - Problem formulation - Classification of Engineering optimization problem

Unit-II SINGLE VARIABLE OPTIMIZATION TECHNIQUES 9

Optimality Criteria - Bracketing Methods: Exhaustive search method - Bounding phase method - Region Elimination Methods: Interval halving method - Fibonacci search method - Golden section search method - Gradient based Methods: Newton - Raphson method - Bisection method - Cubic search method.

Unit-III MULTI VARIABLE AND CONSTRAINED OPTIMIZATION TECHNIQUES 9

Unconstrained optimization techniques - Direct Search Method: Simplex search methods - Hooke- Jeeve's pattern search method - Powell's conjugate direction method - Gradient based method: Cauchy's method - Newton's method - Conjugate gradient method - Constrained optimization techniques - Kuhn - Tucker conditions - Penalty Function methods - Solution by the method of Lagrangian multiplier.

Unit-IV DESIGN OF EXPERIMENTS AND MODELLING 9

Introduction – ANOVA- Factorial Design, Fractional factorial Design, Regression Approach- Two, and multi variable Design, Orthogonal Array Design, Response Surface Methods- Simple Problems.

Unit-V NON TRADITIONAL OPTIMIZATION 9

Introduction to non-traditional optimization - Genetic Algorithm - Bee Colony Algorithm - Particle Swarm Optimization (PSO) and Neural Networks in optimization, Simple Applications.

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	R.PanneerSelvam	Design and Analysis of Experiments	PHI Learning Private Limited	2012
2.	Ashok D. Belegundu,R. Tirupathiand Chandrupatla	Optimization Concepts and Applications in Engineering	Pearson Education	2014
3.	K. Deb	Optimization for Engineering Design Algorithms and Examples	Prentice Hall of India Pvt	2010
4.	Panos Y. Papalambros and Douglass J. Wilde	Principles of Optimal Design: Modelling and Computation	Cambridge University Press	2000
5.	G. V. Reklaitis, A. Ravindram and K. M. Ragsdell	Engineering Optimization - Methods & Application	Wiley	2006

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23CAE02	ADVANCED TOOL DESIGN	L	T	P	C
		2	1	0	3

Course Objective:

- To introduce design process of tools.
- To develop solutions for the design of tools.
- To develop skills to reduce the overall cost to manufacture a product by making acceptable parts at the lowest cost.
- To understand the basics of designing jigs and fixtures.
- To familiarize the methods to increase the production rate by designing tools to produce parts as quickly as possible.
- To design tools that produce parts with the required precision.

Course Outcomes:

23CAE02.CO1	Familiarize the cutting tools, tool holders and cutting fluids.
23CAE02.CO2	Comprehend and design cutting tool systems.
23CAE02.CO3	Understand the design consideration of jigs and fixtures.
23CAE02.CO4	Design jigs and fixtures for various operations.
23CAE02.CO5	Design and draft press to oldies.
23CAE02.CO6	Design and analyze tools for CNC machine tools.

Unit-I INTRODUCTION TO TOOL DESIGN 9

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

Unit-II DESIGN OF CUTTING TOOLS SYSTEMS 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 9

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 9

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 9

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 positions- Tool presetting - General explanation of the Brown and Sharp machine.

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Wilson F.W	Fundamentals of Tool Design	ASTME,Prentice Hall India,	2010
2.	E.G.Hoffman	Jig and Fixture Design	Thomson Asia PvtLtd,Singapore	2004
3.	Venkataraman K	Design of Jigs, Fixtures and Press tools	TMH	2005
4.	Donaldson Cyrll, George H.LeCain and Goold V.C	Tool Design	TMH ,36th Reprint,.	2006
5.	G.C Sen and A.Bhattacharaya	Principle of Machine Tools	New Central Book Agency Kolkata	2009

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23CAE03	COMPUTER CONTROL IN PROCESS PLANNING	L	T	P	C
		2	1	0	3

Course Objective:

- To impart knowledge about the basics of process planning.
- To impart knowledge on conventional tolerances used in part design.
- To comprehend various group technology coding systems.
- To understand the basic concept of process engineering and various process planning approaches.
- To familiarize the various systems and tools required for computer aided process planning.
- To provide the knowledge about structure and operations of integrated process planning systems

Course Outcomes:

23CAE03.CO1	Explain the various process activities of process planning.
23CAE03.CO2	Construct geometrical modeling for process planning.
23CAE03.CO3	Understand and explain various group technology coding systems.
23CAE03.CO4	Comprehend and explain the process engineering and various process planning approaches.
23CAE03.CO5	Recommend the suitable systems for computer aided process planning.
23CAE03.CO6	Discuss the structures and operations of integrated process planning systems.

Unit-I BASIC PRINCIPLES OF PROCESS PLANNING 9

The Place of Process Planning in the Manufacturing cycle - Process Planning and Production Planning Process Planning and Concurrent Engineering, CAPP, and 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 optic 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 - Number of production families - CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP.

Unit-V AN INTERGRATED PROCESS PLANNING SYSTEMS 9

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

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Gideon Halevi and Roland D. Weill	Principles of Process Planning - A logical approach	Chapman& Hall	2010
2.	Nanua Singh	Systems Approach to Computer Integrated Design and Manufacturing	John Wiley & Sons	2008
3.	Rao	Computer Aided Manufacturing	Tata McGraw Hill Publishing Co.	2010
4.	I. Alevi and R.D. Weill	Principles of Process Planning, A logical approach,	Chapman & Hall	2008
5.	H.P. Wang and J.K. Li	Computer-Aided Process Planning (Advances in Industrial Engineering)	Elesvier	1991

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23CAE04	RELIABILITY IN ENGINEERING SYSTEMS	L	T	P	C
		2	1	0	3

Course Objective:

- To provide the knowledge about reliability concept and functions
- To impart knowledge on failure data analysis
- To understand the process of reliability assessment
- To educate the reliability monitoring methods
- To understand reliability improvement of systems.

Course Outcomes:

23CAE04.CO1	Explain the reliability concept and functions
23CAE04.CO2	Comprehend the method of failure data analysis
23CAE04.CO3	Elaborate about reliability assessment
23CAE04.CO4	Formulate the reliability monitoring systems
23CAE04.CO5	Analyze the downtime of systems
23CAE04.CO6	Improve the reliability of the system.

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 9

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 9

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 9

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

Unit-V RELIABILITY MPROVEMENT 9

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

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Singiresu S. Rao	Reliability Engineering	Pearson Education	2016
2.	Roy Billington and Ronald N. Allan	Reliability Evaluation of Engineering Systems	Springer	2007
3.	Dana Crowe and Alec Feinberg	Design for Reliability	CRC Press	2001
4.	Michael Pecht	Product Reliability, Maintainability and Supportability Handbook	CRC Press	2009
5.	Charles E. Ebeling	An introduction to Reliability and Maintainability engineering	Tata McGraw Hill	2000

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23CAE05	TRIBOLOGY IN COMPOSITE MATERIALS DESIGN	L	T	P	C
		2	1	0	3

Course Objective:

- To impart knowledge in the friction, wear and lubrication aspects of machine components.
- To describe fundamental measurements in tribology.
- To describe fundamental fabrication processes for polymer matrix, metal matrix, and ceramic matrix composites.
- To understand the characterization of various composites
- To understand testing methods which influence the Tribological characteristics of surfaces
- To comprehend the issues involved in Tribological diagnosis

Course Outcomes:

23CAE05.CO1	Summarize the basic principles of friction, wear and lubrication.
23CAE05.CO2	Recall measurements of friction and wear for different operating conditions
23CAE05.CO3	Characterize the properties of .composite materials
23CAE05.CO4	Describe various methods of composite materials fabrication.
23CAE05.CO5	Identify the various testing facilities of different composites.
23CAE05.CO6	Interpret the Tribological problems and diagnose them

Unit-I FRICTION, WEAR AND LUBRICATION 9

Topography of Surfaces - Surface features- Adhesive Theory of Sliding Friction -Rolling Friction- Friction properties of metallic and non-metallic materials - Types of wear - Mechanism of various types of wear - Laws of wear - Lubricants and their physical properties- Viscosity and other properties of oils -Additives-and selection of Lubricants- Lubricants standards - Boundary Lubrication- Hydrodynamic lubrication -Elasto and plasto hydrodynamic - Magneto hydrodynamic lubrication - Hydro static lubrication - Gas lubrication.

Unit-II TRIBOLOGICAL MEASUREMENTS 9

Theoretical wear models Wear of Metals and Nonmetals- Surface treatments - Surface modifications - surface coatings methods- Surface Topography measurements -Laser methods - instrumentation - International standards in friction and wear measurements - International standards.

Unit-III CHARACTERIZATION, MANUFACTURING METHODS OF COMPOSITE 9

Introduction to composites - basic concepts, structural applications, classification, strength and stiffness advantages experimental methods for characterization and testing of composite materials - Design of laminates- Manufacture of composite materials: Manufacturing of PMC, MMC, CMC.

Unit-IV TESTING OF COMPOSITE 9

Testing of composite materials - Determination of physical properties such as density, fibre volume ratio, void volume ratio, coefficient of thermal expansion, determination of tensile, compressive and shear properties of unidirectional lamina, determination of interlaminar and intralaminar strength, biaxial testing, characterization of composites with stress concentration - Composite materials friction and wear.

Unit-V DIAGNOSING TRIBOLOGICAL PROBLEMS 9

Introduction - introduction to Problem Diagnosis - Planning First Level of Surface Examination - Second Level of Surface Observation: Electron Microscopy - SEM, TEM and FESEM -Selecting Chemical Analysis Instruments

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	P.K.Mallick	Fiber–Reinforced Composites: Materials, Manufacturing and Design	Maneel Dekker Inc	2007
2.	S.K.Basu, S.N.Sengupta&B.B.Ahuja	Fundamentals of Tribology	Prentice – Hall of India Pvt Ltd, New Delhi	2009
3.	Rabinowicz.E	Friction and Wear of materials	John Willey &Sons, UK	1995
4.	Cameron, A	Basic Lubrication Theory	Ellis Herward Ltd., UK	1981
5.	K.C Ludema	Friction, Wear, Lubrication- A TEXTBOOK IN TRIBOLOGY	CRC Press LLC	1996

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		L	T	P	C
23CAE06	**TRIBOLOGY IN COMPOSITE MATERIALS DESIGN**	**3**	**0**	**0**	**3**

Course Objective:

- To impart knowledge on operating principles of various material handling systems and their limitations.
- Tounderstandthedesignproceduresofvariousmaterialshandlingequipmentusedin industry.
- To enhance the knowledge on drives of hoisting gear.
- To understand the working principle of conveyors
- To understand the working principle of elevators
- To design and perform the selection of various material handling equipment's

Course Outcomes:

23CAE06.CO1	Understand the basics of Material Handling equipment's
23CAE06.CO2	Demonstrate the principles involved in design of Hoists
23CAE06.CO3	Understand and explain the drives of hoisting gear.
23CAE06.CO4	Demonstrate the working principle conveyors
23CAE06.CO5	Demonstrate the working principle of elevators
23CAE06.CO6	Describe various material handling equipment's used in industry.

Unit-I MATERIALS HANDLING EQUIPMENT 9

Introduction - Importance of material handling - Principle of material handling - Factors influences the choice of material handling - Material handling Equipment - Types - Selection and applications - Scope of material handling.

Unit-II DESIGN OF HOISTS 9

Design of hoisting elements - Hemp and wire ropes - Design of ropes - Pulleys - Pulley systems - Sprockets and drums - Load handling attachments - Design of forged hooks and eye hooks - Brake shoe - Band and cone types.

Unit-III DRIVES OF HOISTING GEAR 9

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 9

Types - Description - Design and applications of Belt conveyors - Apron conveyors and escalators - Pneumatic conveyors - Screw conveyors.

Unit-V ELEVATORS 9

Bucket elevators - Design - Loading and bucket arrangements - Cage elevators - Shaft way - Guides - Counter weights - Hoisting machine - Design of fork lift trucks. Case study on popular material handling equipment used in engineering industries.

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Charles Reese	Material handling Systems	Taylor and Francis	2005
2.	Myer Kutz	Environmental Conscious Materials Handling	Wiley series in Environmentally Conscious Engineering	2010
3.	M. Alexandrov	Materials Handling Equipments	MIR Publishers	2002
4.	P.S.G. Tech, Coimbatore	Design Data Book	Kalai kathir Achchagam	2012
5.	Kari H. E.Kroemer	Ergonomic Design of Material Handling Systems	CRC Press USA	2004

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		L	T	P	C
23CAE07	**MECHATRONICS APPLICATIONS IN MANUFACTURING**	**3**	**0**	**0**	**3**

Course Objective:

- To provide the knowledge about measurement systems and Mechatronics design.
- To impart knowledge on various types of sensors and transducers
- To understand the difference between microprocessors and microcontrollers
- To provide the knowledge on programming and interfacing of microprocessors
- To illustrate various programmable logic controllers
- To familiarize the design of various Mechatronics systems

Course Outcomes:

23CAE07.CO1	Explain the basic principles of traditional and Mechatronics systems.
23CAE07.CO2	Comprehend the suitable sensor and transducers for various applications
23CAE07.CO3	Elaborate on architecture of microprocessors.
23CAE07.CO4	Describe the interfacing of various converters..
23CAE07.CO5	Design the programmable logic controllers
23CAE07.CO6	Choose the suitable design for Mechatronics systems

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

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 Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	W.Bolton V	Mechatronics	Pearson 5th Edition , Pearson	2013
2.	R.K.Rajput	Introduction to Mechatronics	4th Edition S.Chand& Co	2012
3.	Michael B.Histand and David G. Alciatore	Introduction to Mechatronics and Measurement Systems	McGraw-Hill International Editions	2002
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, PrenticeHall	2004

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23CAE08	MODELING AND ANALYSIS OF MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the modeling methods, scope, machine utilization of manufacturing systems
- To describe the various concepts of controlling the manufacturing systems.
- To familiarize the concepts of controlling manufacturing processes and evolution analysis in Manufacturing.
- To understand the queuing models in manufacturing system.
- To understand the basic procedure used in the Queuing Networks
- To familiarize the representational power and Stochastic Petri Nets in manufacturing system.

Course Outcomes:

23CAE08.CO1	Understand the principles of manufacturing system models and communications used in the factory
23CAE08.CO2	Describe the various concepts uses in controlling of the manufacturing systems.
23CAE08.CO3	Understand and explain the analysis of manufacturing processes
23CAE08.CO4	Demonstrate the queuing methods and its analysis
23CAE08.CO5	Comprehend and explain the consideration for Queuing Networks
23CAE08.CO6	Explain the elements involved in the Petri NETS

Unit-I MANUFACTURING SYSTEMS & CONTROL 9

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

Unit-II MANUFACTURING PROCESSES 9

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 9

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 9

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

Unit-V PETRI NETS 9

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

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Stanley B. Gershwin, Yves Dallery, Chrissoleon T. Papadopoulos	Analysis and Modeling of Manufacturing Systems	Springer Science & Business Media	2012
2.	Curry, Guy L., Feldman, Richard M	Manufacturing Systems Modeling and Analysis	Springer verlag Berlin Heidelberg	2011
3.	David D. Yao	Stochastic Modeling and Analysis of Manufacturing Systems	Springer Science & Business Media	2012
4.	James MacGregor Smith, Barış Tan	Handbook of Stochastic Models and Analysis of Manufacturing System	Springer Science & Business Media	2013
5.	S. Joshi, Jeffrey Smith S	Computer control of flexible manufacturing systems	Springer Science & Business Media	2012

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		L	T	P	C
23CAE09	**PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING**	**3**	**0**	**0**	**3**

Course Objective:

- To impart knowledge on productivity models and organizational transformations.
- To describe the measurement of productivity.
- To study the organizational transformation
- To impart knowledge reengineering process improvement tools.
- To gather knowledge in reengineering tools and implementation
- To understand the supply chain management.

Course Outcomes:

23CAE09.CO1	Understand the basic concepts of productivity
23CAE09.CO2	Demonstrate the productivity models
23CAE09.CO3	Demonstrate the principles involved in organizational transformation.
23CAE09.CO4	Explain various re-engineering process improvement models.
23CAE09.CO5	Describe the various re-engineering tools.
23CAE09.CO6	Enumerate the principles of supply chain management.

Unit-I INTRODUCTION 9

Productivity concepts - Macro and Micro factors of productivity, Productivity benefit model, productivity cycle.

Unit-II PRODUCTIVITY MODELS SYSTEMS 9

Productivity measurement at International, National and Organizational level, total models- Productivity management in manufacturing and service sector-Evaluation models, improvement models andtechniques.

Unit-III ORGANIZATIONAL TRANSFORMATION 9

Principles of organizational transformation and re-engineering, fundamentals of process reengineering, preparing the workforce for transformation and re-engineering, methodology, guidelines, DSMCQ and PMP model.

Unit-IV RE-ENGINEERING PROCESS IMPROVEMENT MODELS 9

PMI models, Edosomwan model, Moen and Nolan strategy for process improvement, LMICIP model, NPRDC model.

Unit-V RE-ENGINEERING TOOLS AND IMPLEMENTATION 9

Analytical and process tools and techniques - Information and communication technology - Enabling role of IT, RE-opportunities, process redesign – case study. Software methods in BPR - specification of BP, case study - Order, processing, user interfaces, maintainability and reusability.
To study the feasibility of implementing business process re-engineering (BPR) in supply chain management of a manufacturing company.

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	G D Premvrat, Sardana and B S Sahay,	Productivity Management - A systems approach	Narosa Publishers, NewDelhi,	2008
2.	R C Mishra and K Pathak	Maintenance Engineering and Management	PHI	2005
3.	D J Sumant	Productivity engineering and management	TMH, New Delhi	2006
4.	J AEdosomwan	Organizational transformation and process re-engineering	British Library cataloging in pub. data	2007
5.	S K Srivatsava	Industrial Maintenance Management	S Chand and Company	2007

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23CAE10	DESIGN AND MANUFACTURING OF COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the basics of composite materials.
- To describe various types of matrix materials and reinforcements.
- To understand the methods of manufacturing composite materials.
- To comprehend the principles of mechanics of composite laminates
- To demonstrate the testing methods of composite materials
- To familiarize the recent trends in composite materials

Course Outcomes:

23CAE10.CO1	Familiarize the fundamentals of composite materials
23CAE10.CO2	Recall the various types of matrix and reinforcements.
23CAE10.CO3	Demonstrate the manufacturing techniques of composite materials.
23CAE10.CO4	Demonstrate and design different laminated composite.
23CAE10.CO5	Illustrate different testing methods of composite materials.
23CAE10.CO6	Explain the recent trends in composite materials

Unit-I INTRODUCTION TO COMPOSITE MATERIALS 9

Definition- Classifications - Matrix materials- Polymers – metals – ceramics- properties- Reinforcements- particles- whiskers, Fibers - glass- ceramic- aramid and carbon fibers - fabrication and properties, Metal Matrix Composites - classifications- particle reinforced- dispersed strengthened- fiber reinforced composites - rule of mixture- matrix/reinforcement interface - wettability-advantages - limitations and applications of composites.

Unit-II MANUFACTURING OF COMPOSITES 9

Manufacturing of Polymer Matrix Composites - Hand lay-up - Spray technique - Bag molding - Compression molding- Filament winding – Pultrusion - Resin transfer molding (RTM) - Structural reaction injection molding (SRIM) - Manufacturing of Metal Matrix Composites - Liquid state process- Liquid infiltration- Vortex method- Squeeze casting techniques - Solid state process-Diffusion bonding- Powder Metallurgy - In situ process - Manufacturing of Ceramic Matrix Composites - Hot pressing- reaction bonding - liquid infiltration- directed oxidation process

Unit-III MECHANICS OF LAMINA AND LAMINATED COMPOSITES 9

Introduction to lamina and laminate- Characteristics of fiber reinforced lamina – Fundamentals- Orientations of fibers- Elastic properties of lamina- Coefficient of linear thermal expansion- Stress - Strain relationship for thin lamina- Compliance and stiffness Matrices - Laminated Structures - Symmetric laminates- angle ply laminates - Cross ply laminates- Quasi -Isotropic laminates- Inter- Laminar Stresses

Unit-IV TESTING OF COMPOSITE MATERIALS 9

Static Mechanical properties- Tensile – Compressive- Flexural -In plane shear- inter-laminar shear strength – Fatigue- Impact - other properties - Environmental effects - long term properties - creep - stress rupture- fracture behavior and damage tolerance- methods of improving damage tolerance, wear corrosive- fatigue and flexural behavior of particulate reinforced composites.

Unit-V RECENT TRENDS IN COMPOSITEMATERIALS 9

Research trends in polymer, metal and ceramic matrix composites - Advanced composites - Nano, bio and hybrid composites – Applications.

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Robert M. Jones	Mechanics of Composite Materials	CRC Press, NY	2015
2.	Krishnan K. Chawla	Composite Materials- Science and Engineering	Springer	2012
3.	P.K. Mallick	Fiber-Reinforced Composites: Materials, Manufacturing, and Design	Third Edition- CRC Press	2007
4.	M William D. Callister	Materials Science And Engineering - An Introduction	Wiley	2010
5.	P.K.Mallick	Fiber Reinforced Composites: Materials, Manufacturing and Design	ManeelDekkerInc,	2007

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23CAE11	INTEGRATED MECHANICAL DESIGN	L	T	P	C
		3	0	0	3

Course Objective:

- To familiarize the fundamentals in the design process with steady and variable stresses
- To design shafts to satisfy functional and strength requirements.
- To describe the principles of gear and gearboxes.
- To describe characteristics shared by clutches and brakes.
- To learn to use standard practices and standard data and design springs, levers &flywheels.
- To learn to use catalogues and standard conveying equipment's.

Course Outcomes:

23CAE11.CO1	Understand the design fundamentals in mechanical design.
23CAE11.CO2	Analyze steady and variable stresses in shafts.
23CAE11.CO3	Acquire, articulate and apply specialized terminology and knowledge relevant to gear and gear boxes.
23CAE11.CO4	Understand the dynamics and thermal aspects of brakes and clutches and design them.
23CAE11.CO5	Acquire and demonstrate competency in integrated design.
23CAE11.CO6	Understand and explain the principles and types of conveying equipment's.

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

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 & CLUTCHES 9

Dynamics and thermal aspects of brakes and clutches – Integrated design of brakes and clutches for machine tools, automobiles and mechanical handling equipment's.

Unit-IV INTEGRATED DESIGN 9

Integrated Design of systems consisting of shaft, bearings, springs, motor, gears, belt, rope, Cam & Follower, Machine Tools.

Unit-V CONVEYING EQUIPMENTS 9

Belt conveyors - chain conveyors – apron conveyors – escalators – flight conveyors – roller conveyors Oscillating conveyors. Design of belt conveyors, screw conveyors and pneumatic conveyors.

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Norton L. R	Machine Design – An Integrated Approach	Pearson Education, Fifth Edition	2014
2.	Steve F. Krar	Technology of Machine Tool	McGraw Hill	2013
3.	Shigley, J.E	Mechanical Engineering Design	McGraw Hill	2014
4.	Dr. Sadhu Singh	Machine Design	KHANNA BOOK PUBLISHING	2015
5.	Dr. P.C.Sharma& Dr. D.K.Aggarwal,	Machine Design	S. K. Kataria& Sons, 11th edition	2011

Approved Data Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	P.S.G. Tech	Design Data Book	Kalai kathir Achchagam, Coimbatore	2003
2.	Lingaiah. K. and NarayanaIyengar	Machine Design Data Hand Book	Vol. 1 & 2, Suma Publishers, Bangalore.	1994

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		L	T	P	C
23CAE12	**ADDITIVE MANUFACTURING**	**3**	**0**	**0**	**3**

Course Objective:

- To provide an exhaustive knowledge of various rapid prototyping techniques
- To understand various rapid prototyping systems
- To educate the emerging trends and applications of Additive Manufacturing (AM) technology.
- To educate fundamental and advanced knowledge in the field of the associated aerospace, architecture, art, medical and industrial applications.
- To make familiar in reverse engineering and cad modeling
- To make familiar about materials and process parameters in prototype development.

Course Outcomes:

23CAE12.CO1	Classify different prototyping techniques.
23CAE12.CO2	Describe various rapid prototyping systems
23CAE12.CO3	Understand file conversion technique of file formats for rapid prototype systems.
23CAE12.CO4	Select the suitable additive manufacturing process for respective applications.
23CAE12.CO5	Describe reverse engineering in rapid prototyping.
23CAE12.CO6	Describe the properties of various materials used in prototyping

Unit-I INTRODUCTION 9

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 LIQUID BASED AND SOLID BASED RAPID PROTO TYPING SYSTEMS 9

Stereo lithography Apparatus SLA Principle, Part building processes, Photo polymerization of SL resins, Part quality, Recoating issues, Materials. Solid Ground Curing, Fused Deposition Modeling and Laminated Object Manufacturing Working Principle - Process parameters and Materials.

Unit-III POWDER BASED AND OTHER RAPID PROTO TYPING SYSTEMS 9

Selective Laser Sintering Principle, Process Variables, Indirect and direct SLS - Powder structures, Materials, Post processing, Surface deviation and Accuracy - Three dimensional Printing Principle, Physics of 3DP, Types, Process capabilities, Solid, Liquid and Powder based 3DP systems.

Unit-IV REVERSE ENGINEERING AND CAD MODELING 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-V MATERIALS PROPERTIES 9

Role of materials - Viscous flow - Photo polymerization - Sintering - Infiltration - Materials for AM Processes - Mechanical Properties of AM Parts - Material properties, Colour, Dimensional accuracy, Stability, Surface finish, Machinability, Environmental resistance, Operational properties of products developed Direct Metal Deposition, Ballistic Particle Manufacturing, Electron Beam Melting and Laser Engineered Net Shaping Working Principle.

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Ian Gibson, DavidW.Rosen	Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing	Springer	2015
2.	AmitBandyopadhyay ,Susmita Bose	Additive Manufacturing	Taylor &Francis Group	2016
3.	Liou, L.W. and Liou, F.W	Rapid Prototyping and Engineering applications: A tool box for proto type development"	CRC Press	2011
4.	Kamrani, A.K. and Nasr, E.A	Rapid Prototyping: Theory and practice	Springer	2006
5.	Chua, C.K., Leong K.F. and Lim C.S	Rapid prototyping: Principles and applications	World Scientific Publishers	2010

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23CAE13	GEOMETRIC MODELING	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the mathematical representation of curves
- To interpret the mathematical representation of surfaces
- To interpret the mathematical representation of surfaces
- To comprehend visual realization.
- To familiarize computer animation

Course Outcomes:

23CAE13.CO1	Develop the mathematical model of curves and surface.
23CAE13.CO2	Develop the mathematical representation of surface.
23CAE13.CO3	Develop the mathematical model of solid based on the design application.
23CAE13.CO4	Develop visual realization algorithm.
23CAE13.CO5	Design the animation of product.

Unit-I TYPES AND MATHEMATICAL REPRESENTATION OF CURVES 9

Introduction, Wireframe models, parametric representation of curves (analytic synthetic),curve Manipulation, design examples.

Unit-II MATHEMATICAL REPRESENTATION OF SURFACES 9

Surface models, parametric representation, surface manipulation, design applications.

Unit-III MATHEMATICAL REPRESENTATION OF SOLIDS 9

Fundamentals of solid modeling, Boundary representation, constructive solid geometry, sweep Representation, analytic solid modelers, design applications.

Unit-IV VISUAL REALISATION 9

Model cleanup, hidden line removal, hidden surface removal, shading, and colouring

Unit-V COMPUTER ANIMATION 9

Computer animation, animation systems types and techniques, design applications, Computer Graphics Standard

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	David Solomon	Computer Graphics and Geometric Modeling	Springer	2015
2.	Michael EMortenson	Geometric Modeling	JohnWiley&Sons Inc.,SecondEdition	2010

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23CAE14	CORROSION ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

- Definition and classification of corrosion.
- Principles of corrosion, common corrosion forms,
- Different corrosion testing methods.
- Corrosion control methods and material selection for cost reduction.
- Modern theories to explain corrosion

Course Outcomes:

23CAE14.CO1	Identity the type of corrosion.
23CAE14.CO2	Correlate the damage with the cause of corrosion.
23CAE14.CO3	Identify the correct method of testing any corrosion.
23CAE14.CO4	Select the appropriate preventive method to avoid corrosion.
23CAE14.CO5	Select the significant coating for corrosion prevention.
23CAE14.CO6	Apply modern method of corrosion measurement

Unit-I INTRODUCTION 9

Definition, corrosion environments, damage, classification of corrosion. Principles and corrosion rate expressions. Environmental effects such as velocity, temperature, galvanic coupling. Metallurgical and other aspects

Unit-II DIFFERENT FORMS OF CORROSION 9

Uniform attack, galvanic corrosion, crevice corrosion, fitting corrosion, inter– granular corrosion, selective leaching, erosion corrosion, stress corrosion and hydrogen damage. Pitting: pit shape and growth, velocity, metallurgical variables, evaluation of pitting damage, prevention.

Unit-III CORROSION TESTING METHODS 9

Classification, purpose, surface preparation, measuring and weighing, duration, plant interval test, NACE test methods, slow – strain rate test and paint test. Composites testing: Exposure techniques, Huey test, Sea water test, Stress corrosion, Corrosion of palstics, Invivo corrosion.

Unit-IV CORROSION PREVENTION METHODS 9

Selection of metals and alloys–Cast iron, steel, Al, Mg, Ti, Composites and Refractory metals. Non-metallic: Thermosetters, laminates and reinforced plastics, Rubbers, Wood, Ceramics, Carbon and Graphite. Alteration of environment such as changing mediums, lowering temperature, design rules, design of cathodic and anodic protection, selected coating techniques to prevent corrosion; Failure analysis. High temperature corrosion.

Unit-V ADVANCED TECHNIQUES 9

Modern theory–principles and applications, electrode kinetics, predicting corrosion behavior, corrosion prevention, Corrosion rate measurements in Petroleum Industry with examples

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Pierre R. Roberge	Handbook of Corrosion Engineering	MCGraw-Hill Newyork	2012
2.	Zaki Ahmad	Principles of Corrosion Engineering and Corrosion Control	Butterworth-Heinemann	2006

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		L	T	P	C
23CAE15	**NANO MATERIALS AND TECHNOLOGY**	**3**	**0**	**0**	**3**

Course Objective:

- Students are able to understand the nanotechnology approach and challenges
- To give the student familiarities about materials of nanotechnology
- Students are able to understand the Nano structurers
- Students are able to learn Nano fabrication
- Students are able to understand special Nano materials
- Students are able to understand bio materials

Course Outcomes:

23CAE15.CO1	Understand the developments and challenges in Nano technology
23CAE15.CO2	Understand synthesis and properties of nanostructured materials
23CAE15.CO3	Analyze magnetic and electronic properties of Nano materials
23CAE15.CO4	Analyze Nano fabrication methods and their applications
23CAE15.CO5	Understand the characterization of Nano and bio materials and their use
23CAE15.CO6	Analyze the synthesis and characterization of Nano wires and tubes

Unit-I INTRODUCTION 9

Nanoscale, Properties at Nanoscale, advantages and disadvantages, importance of Nanotechnology, Bottomup and Top-down approaches, challenges in nanotechnology, proximal probe technologies

Unit-II MATERIALS OF NANOTECHNOLOGY 9

Introduction, Si-based materials, Ge-based materials, Ferroelectric materials, Polymer materials, GaAs& InP (HI-V) group materials, Nano tribology and materials, characterization using Scanning Probe Microscope, AFM, FFM

Unit-III NANO STRUCTURES 9

Zero dimensional Nanostructure (Nano particles), synthesis procedure, characterization techniques, properties and applications of Nano particles One Dimensional Nanostructures (Nano Wires, Nano Tubes), various Synthesis procedure, characterization procedure and principles involved, properties and applications of Nano Wires, Types of Nano Tubes, Synthesis procedure, characterization properties and applications of Nano Tubes

Unit-IV NANO FABRICATION 9

Introduction, Basic fabrication techniques (Lithography, thin film deposition, and doping), MEMS fabrication techniques, Nano fabrication techniques (E-beam Nano-imprint fabrication, Epitaxy and strain engineering, Scanned probe techniques).

Unit-V SPECIAL NANO MATERIALS 9

Nano Composites: Introduction, Synthesis procedures, various systems (metal-polymer, metal ceramics and Polymer-ceramics), Characterization procedures, applications, Nano Biomaterials: Introduction, Biocompatibility, anti-bacterial activity, principles involved, applications

Total Periods: 45

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	A.K. Banopadya	Nano Materials	New Age Publications	2012
2.	T. Pradeep	Textbook of Nanoscience and Nanotechnology	McGraw Hill Edu.	2011

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EMPLOYABILITY ENHANCEMENT COURSES

(EEC)

For

CAD/CAM

		L	T	P	C
23CAM01	**PROJECT WORK PHASE -I**	**0**	**0**	**12**	**6**

Course Objective:

- To achieve integrated mechanical design of a product through parts design, assembly and preparation of manufacturing drawings

Course Outcomes:

23CAM01.CO1	Choose an engineering problem in a current industrial scenario.
23CAM01.CO2	Do intensive and related literature review
23CAM01.CO3	Decide the working methodology of the project

Each student has to work under a project supervisor. Based on the current industrial scenario, any relevant problem should be selected for the project with the consultation of the supervisor. Literature review should be done related to the problem considered. The working methodology of the project work for the phase II should be decided. These activities should be registered in a report and submitted by the student which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester examination the project work is evaluated based on oral presentation and the project report, jointly by external and internal examiners.

Total Periods: 90

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		L	T	P	C
23CAM02	**PROJECT WORK PHASE -II**	**0**	**0**	**24**	**12**

Course Objective:

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.

Course Outcomes:

23CAM02.CO1	Apply knowledge and demonstrate to manage project in multi-disciplinary.
23CAM02.CO2	Design and conduct experiments to interpret data pertaining to engineering problems
23CAM02.CO3	Apply contextual knowledge to assess social, health and cultural issues and endue to professional engineering practice.
23CAM02.CO4	Prepare documentation and presentation for engineering activities for society
23CAM02.CO5	Perform effectively as leader in multi-disciplinary terms.

Based on the work methodology decided in the Phase I, the project is further developed. Necessary modeling and analysis is done using required software. The project is fabricated. The analytical results and the experimental results are validated. Three reviews will be conducted periodically by a committee constituted by the Head of the Department. A project report to be prepared by the students along with which the project has to be submitted for the final viva voce examination

Total Periods: 450

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(AUTONOMOUS)
RASIPURAM-637 408, NAMAKKAL Dist.

		L	T	P	C
23CAM03	**PROJECT WORK PHASE -II**	**0**	**0**	**4**	**1**

Course Objective:

- To encourage the students to comprehend the knowledge acquired from various premier journals through periodic exercise.
- To gain ability to understand and comprehend any given problem related to mechanical engineering

Course Outcomes:

23CAM03.CO1	Recall the basic principles of previous semester courses.
23CAM03.CO2	Comprehend and analyze problems associated with mechanical engineering
23CAM03.CO3	Make an oral presentation

The students have to recall the principles and fundamental of the courses studied in their previous semesters. Along with that knowledge and that acquired from reading various premier journals of their choice, the students have to make an oral presentation. Weekly examination will be conducted and evaluated. The average of the marks obtained in the tests will be considered for the end semester evaluation.

Total Periods: 30

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23CAM04	PROJECT WORK PHASE -II	L	T	P	C
		0	0	4	1

Course Objective:

- To give an opportunity to the student to get hands on training in the fabrication of one or more components of a complete working model, which is designed by them.

Course Outcomes:

23CAM04.CO1	Use of design principles and develop conceptual and engineering design of any components.
23CAM04.CO2	Ability to fabricate any components using different manufacturing tools.

The students have to work individually under a project supervisor. The device/ system/component(s) to be designed and /analysed may be decided in consultation with the supervisor and if possible with an industry. A project report to be submitted by the student and the model, will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester examination the project work is evaluated based on oral presentation and the project report jointly by external and internal examiners.

Total Periods: 60

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