SYLLABI BOOK

MASTER OF TECHNOLOGY
MECHANICAL ENGINEERING

Department of Mechanical Engineering
Faculty of Technology
Dharmsinh Desai University
Nadiad – 387 001, Gujarat, India.

TEACHING SCHEME FOR THE COURSE
M. TECH., CAD/CAM

SEMESTER - I

Code	Subject Title	Teaching Scheme & Credit			Examination Scheme					
		Lect	Tut	Prac	TH	Sess	Prac	TW	Total	Credit
MM109	ADVANCED MACHINE DESIGN	4	0	0	60	40	---	---	100	4.0
MM110	COMPUTER AIDED DESIGN	3	0	4	60	40	25	25	150	5.0
MM111	COMPUTER AIDED PRODUCTION MANAGEMENT	3	0	2	60	40	25	25	150	4.0
MM112	ADVANCE MATERIALS & MANUFACTURING TECHNOLOGIES	4	0	0	60	40	---	---	100	4.0
MM113	OPTIMIZATION TECHNIQUES	4	0	2	60	40	25	25	150	5.0
---	PRODUCT DESIGN AND DEVELOPMENT									
---	MECHANICAL VIBRATION									
MM114	RESEARCH METHODOLOGY AND IPR	1	0	2				100	100	2.0
MM108	SEMINAR - I	0	1	0	---	---	---	50	50	1.0
									800	25.0

SEMESTER - II

Code	Subject Title	Teaching Scheme & Credit			Examination Scheme					
		Lect	Tut	Prac	TH	Sess	Prac	TW	Total	Credit
MM201	FINITE ELEMENT METHODS	3	0	4	60	40	25	25	150	5.0
MM202	COMPUTER AIDED MANUFACTURING	4	0	2	60	40	25	25	150	5.0
MM209	HYDRAULIC AND PNEUMATIC SYSTEMS	3	0	4	60	40	---	---	100	5.0
MM204	RAPID PROTOTYPING & TOOLING	4	0	2	60	40	25	25	150	5.0
---	MODELING AND SIMULATION									
---	MECHATRONICS IN MANUFACTURING SYSTEMS									
---	TRIBOLOGY IN DESIGN									
MM211	ROBOTICS	4	0	2	60	40	25	25	150	5.0
---	DESIGN OF MATERIAL HANDLING EQUIPMENTS									
---	ADVANCED TOOL DESIGN									
---	ARTIFICIAL INTELLIGENCE									
MM210	SEMINAR - II	0	1	0	---	---	---	50	50	1.0
									750	26.0

SEMESTER - III

Code	Subject Title	Teaching Scheme & Credit			Examination Scheme					
		Lect	Tut	Prac	TH	Sess	Prac	TW	Total	Credit
MM301	DISSERTATION - I	0	0	20	---	---	225	125	350	10.0
MM302	SEMINAR - I	0	2	0	---	---	---	50	150	2.0
									500	12.0

SEMESTER - IV

Code	Subject Title	Teaching Scheme & Credit			Examination Scheme					
		Lect	Tut	Prac	TH	Sess	Prac	TW	Total	Credit
MM401	DISSERTATION - II	0	0	20	---	---	300	150	450	10.0
MM402	SEMINAR - II	0	2	0	---	---	---	50	50	2.0
									500	12.0

(MM109) ADVANCE MACHINE DESIGN

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	Tut	Prac	Theory	Sess.	TW	Prac	Total	Lect	Tut	Prac	Total
4	0	0	60	40	---	---	100	4	0	0	4

OBJECTIVES OF THE COURSE

- Students shall be able to understand stresses and strain in three dimensions, basic concepts of fracture mechanics, shall be able to apply fracture mechanics concepts for designing various mechanical components, shall understand fatigue and surface failures and understand the design of components subjected to fatigue loading

DETAILED SYLLABUS

1 STRESSES IN 3D

Concept of Continuum, Homogeneity and Isotropy, Types of forces on a body, force, state of stress as a point, rectangular stress components, equality of cross shear, stress components of an arbitrary plane, principal planes and stresses, stress invariants, hydro-static stress and stress deviator, Mohr's circle for 3D state of stress, plane of maximum shear, octahedral stresses, differential equilibrium equation, stress transformation

2 STRAIN IN 3D

Deformation, types of strain, rectangular strain components, concept of total strain, rigid body rotation, principle strain and axes, isotropic and shear strain, strain invariants, strain compatibility conditions, strain transformation, plane stress and plane strain, stress-strain relationship and generalized Hook's law, stress strain relationship for anisotropic, orthotropic and isotropic materials

3 THEORIES OF ELASTIC FAILURE

Concept of factor of safety, Maximum principal stress theory, maximum shear stress theory, maximum principal strain theory, Maximum strain energy theory, maximum shear strain energy theory

4 FRACTURE MECHANICS

Introduction and overview of fracture mechanics, fracture mechanics approach to design,effect of material properties on fracture, Linear elastic fracture mechanics (LEFM), atomic view of fracture, stress concentration effect, Grifith theory, energy release rate, instability and R-curve, stress analysis of cracks, stress intensity factor and different modes of loading, crack tip plasticity, fracture toughness, determination of plastic zone shape and size, stress intensity factor as a failure criteria

5 ENGINEERING STATISTICS

Introduction to experimental design, basic statistical concepts, sampling design, null hypothesis, alternate hypothesis, type I & type II errors - critical region, confidence interval, level of significance, hypothesis testing , design and analysis of single-factor experiments using ANOVA, Introduction to factorial designs, two factor factorial experiments using ANOVA

6 FATIGUE FAILURE

Introduction, types of Fatigue failure, mechanism of fatigue failure, fatigue failure models, stress-Life approach, strain-life approach, LEFM approach, fatigue loads, measuring fatigue failure criteria, fully reversed stresses, combined mean and alternating stress, creating S-N curve, estimating fatigue failure criteria, estimating theoretical endurance limit and actual endurance limit, correction factors, notches and stress concentration, designing for fully reversed stresses for finite and infinite life, designing for fluctuating stresses for finite and infinite life, designing for Soderberg, Goodman and Gerber Criteria, creating modified Goodman diagram, designing for multi-axial stresses in fatigue

7 SURFACE FAILURE

Introduction, surface geometry, mating surfaces, friction: general estimation of coefficient of friction, effect of various factors on friction, types of wear: adhesive wear, abrasive wear, corrosion wear, surface fatigue, surface contact geometry: spherical contact, cylindrical contact, general contact, contact pressure, contact patch, static stress distribution, dynamic contact stresses, surface fatigue strength: design for N cycles

LEARNING OUTCOMES

On successful completion of the course, student will be able to;

- understand stresses and strain in 3D context and understand stress-strain relationship for different types of materials
- incorporate engineering statistics in mechanical design
- understand design procedure for components subjected to fatigue loading and different types of surface failures and design procedure for the same

REFERENCE BOOKS

1. Advanced Mechanics of Solids, L. S. Srinath, Tata McGraw Hill
2. Fracture Mechanics - Fundamentals and applications, T. L. Anderson, CRC Press
3. Elementary Engineering Fracture Mechanics, David Broek, MatrinusNijhoff Publishers
4. Elements of Fracture Mechanics, Prashant Kumar, McGraw Hill
5. Design and analysis of experiments, D.C. Montgomery, John Wiley and sons

6. Research Methodology, C. R. Kothari, New Age International Pvt Ltd
7. Machine Design - An Integral Approach, Robert L. Norton, Pearson Prentice Hall
8. Design of Machine Elements, V. B. Bhandari, Tata McGraw Hill

(MM110) COMPUTER AIDED DESIGN

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	Tut	Prac	Theory	Sess.	TW	Prac	Total	Lect	Tut	Prac	Total
3	0	4	60	40	25	25	150	3	0	2	5

OBJECTIVES OF THE COURSE

- Understand the basic fundamentals of computer aided design theoretically as well as practically by modeling software
- To learn about scan conversion of various geometrical entities and 2D &3D transformations of the basic entities like line, circle, ellipse etc along with practice on computer programme.
- To understand about representation of curves, surfaces and solid modeling

DETAILED SYLLABUS

1 FUNDAMENTALS OF CAD

Introduction to CAD, Conventional design v/s Computer aided design, Interactive computer graphics, CAD workstation, Hardware used in CAD, CAD software, CAD programming

2 COMPUTER GRAPHICS

Scan conversion, Algorithms to generate various 2D geometries such as line, circle etc.

3 GEOMETRIC TRANSFORMATION

Various 2D geometric transformation, Homogeneous coordinate system, Inverse transformation, Composite transformation, Coordinate transformation, 3D geometric transformation, Projections of geometric model such as Orthographic Projections, Isometric Projections, Perspective Projections etc.

4 GEOMETRIC MODELLING

Introduction to geometric modeling, Wireframe modeling, Analytical and Synthetic curves, Representation of curves, Non-Parametric representation, Parametric representation, Parametric representation of analytical curves, Parametric representation of synthetic curves, Introduction to NURBS

Analytical and Synthetic surfaces, Parametric representation of surfaces

Geometry and topology data of solid model, Representation schemes of Solids-Generalized sweeps, Spatial Occupancy enumeration, Cellular decomposition, Constructive solid geometry (C-Rep), Boundary representation (B-Rep), etc. Feature based modeling, Parametric representation of solids

Assembly modelling – top down and bottom up modelling concept

5 CAD STANDARDS

Need of CAD data exchange, CAD standards such as IGES, PDES, STEP etc., CAD/CAM

Integration trough data exchange standards

6 COMPUTER AIDED DESIGN OF MACHINE COMPONENTS

To develop computer programs using Programming language for some of the machine components such as shafts, springs, couplings, clutches, brakes, levers, gears, belts

LEARNING OUTCOMES

After the completion of the course student will be able to:

- Describe the mathematical basis in the technique of representation of geometric entities including points, lines, and parametric curves, surfaces and solid, and the technique of transformation of geometric entities using transformation matrix
- Use CAD software to generate a computer model and technical drawing for well-defined part or assembly

REFERENCE BOOKS

1. "Computer Graphics" by Hearn Donald & Baker M. Pauline, , Prentice-Hall of India Pvt. Ltd., 2nd Edition, 1997.
2. "Mathematical Elements for Computer Graphics" by David F. Rogers & J. Alan Adams, McGraw Hill, 2nd Edition, 1990.
3. "CAD, CAM and Automation" by Haideri Farazdak, Nirali Prakashan, 2014.
4. "CAD/CAM" by Zimmer & Groover,Prentice Hall of India.
5. "Geometric modeling" by Mortenson, M. E., Industrial Press, 2006.
6. "CAD/CAM - Theory and Practice" by Zaid Ibrahim, McGraw Hill, International Edition, 1998.
7. "CAD/CAM: Principles and Applications" by Rao, P.N., McGraw Hill Publication, 2nd Edition, 2004.
8. "CAD/CAM/CIM" by S. Radhakrishan, New edge International (P) Ltd publisher

(MM111) COMPUTER AIDED PRODUCTION MANAGEMENT

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	Tut	Prac	Theory	Sess.	TW	Prac	Total	Lect	Tut	Prac	Total
3	0	2	60	40	25	25	150	3	0	1	4

OBJECTIVES OF THE COURSE

- The aim of this subject is to provide students the insight of how production management is done through various methods and computer algorithms widely used for plant layout design, process planning, material planning and scheduling.

DETAILED SYLLABUS

1 COMPUTER AIDED FORECASTING

Nature and use of forecast, different forecasting methods, selection of forecasting technique, measurement of forecast Accuracy, Adoptive methods.

2 COMPUTER AIDED FACILITY DESIGN

Computerized relative allocation of facility technique, automated layout design program and computerized relationship layout planning for facility location and layout.

3 COMPUTER AIDED PROCESS PLANNING

Generative and variant types, backward and forward approach, feature based and CAD based CAPP.

4 MRP

Master Production Schedule (MPS), Materials Requirement Planning (MRP), Lot sizing in MRP Systems, Evolution from MRP to Manufacturing Resource Planning (MRP II)

5 PRODUCTION SCHEDULING

Single Machine Scheduling, Flow Shop Scheduling, Job Shop Scheduling, Rules of Optimized Production Technique schedule, Use of Kanban for scheduling

6 GROUP TECHNOLOGY

Part family, Part classification and coding, Production flow analysis, ROC, SLCA, cellular manufacturing, quantitative analysis in cellular manufacturing, Holier Method-I, II.

7 ERP

Introduction, main features, generic model of ERP system, selection of ERP, proof of concept approach, analytic hierarchy approach, ERP implementation

LEARNING OUTCOMES

After successful completion of the course, student will be able to;

- Understand various methods of forecasting and forecasting errors.

- Identify suitable algorithm for plant layout design and suitable scheduling techniques.
- Understand Cellular Manufacturing and various module of ERP software.

REFERENCE BOOKS

1. Automation, Production Systems and Computer Integrated Manufacturing, by Mikell P. Groover, Prentice Hall of India, New Delhi.
2. Modern Production/Operations Management, by Elwood S. Buffa and Rakesh K. Sarin, John Wiley publication.
3. Production and Operations Management by R. Paneerselvam, Prentice –Hall of India Private Limited, New Delhi.
4. Facilities planning, by J. A. Tompkins and J. A. White, John Wiley publication.
5. Plant layout & Material Handling, by G. K. Aggarwal, Jain Publishers, New Delhi

(MM112) ADVANCED MATERIALS AND MANUFACTURING TECHNOLOGIES

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	Tut	Prac	Theory	Sess.	TW	Prac	Total	Lect	Tut	Prac	Total
4	0	0	60	40	---	---	100	4	0	0	4

OBJECTIVES OF THE COURSE

- To understand the properties, performance, applications of advanced materials.
- To understand processing and manufacturing techniques for advanced materials
- To understand about some advanced topics in casting, welding and forming processes

DETAILED SYLLABUS

1 ADVANCED MATERIALS

Properties and applications of - Special steels, Alloy cast iron, Super alloys, Ferro electric and piezoelectric materials, Advanced magnetic materials, Advanced engineering polymer materials, Advanced ceramic and composite materials, photo conducting and photovoltaic materials, electro-optic materials, Lasers, Biomaterials, Smart materials

Nano materials & technology: Classification, size effect on structural and functional properties, Processing and properties of nanocrystalline materials, thin films and multi-layered coatings, single walled and multiwalled carbon nanotubes

2 MATERIALS PROCESSING

Conventional processing techniques for advanced materials, special processing techniques, use of computers in metal processing

3 PERFORMANCE OF MATERIALS IN SERVICE

Service performance, corrosion and its control, Performance of materials at High & low temperatures, Radiation damage and recovery

4 MECHANICAL BEHAVIOUR OF MATERIALS

Mechanical testing of materials, mechanisms of failures, fracture theory.

5 METAL CASTING

Appraisal of various casting processes, selection of casting process, general design considerations for casting, casting tolerances, use of solidification simulation in casting design product design rules for sand casting

6 METAL JOINING

Appraisal of various welding processes, Factors in design of weldments, general design guidelines, pre and post treatment of welds, effects of thermal stresses in weld joints, cost estimation in welding and its examples

7 FORGING AND EXTRUSION

Design factors for Forging, Closed die forging design, parting lines of dies, general design recommendations, Design guidelines for extruded sections, design principles for Punching, Blanking, Bending, Deep Drawing

8 MICRO AND NANO MANUFACTURING

Introduction to Micro and Nano manufacturing technology, advantages and applications of nanotechnology, Overview of Nano Fabrication Methods: Top-down and bottom-up approaches, lithography, deposition, CVD, PVD, etching, and material modification methods, processes and equipment

LEARNING OUTCOMES

After the completion of the course students will be able to:

- Understand properties of advanced materials and their processing techniques.
- Select suitable material for various applications
- Understand modern manufacturing techniques and their analysis.

REFERENCE BOOKS

1. Design for Manufacture by John Cobert / Adisson Wesley, 1995
2. ASM Handbook, Vol.20
3. Engineering Design- A Material and Processing Approach by George E. Dieter, McGraw Hill Intl., 2nd Edition, 2000
4. Product design and Manufacturing by A.K Chitale and R.C Gupta, Prentice Hall of India, New Delhi, 2003
5. Design for Manufacturability by James Bralla, McGraw Hill
6. Design and Manufacturing by Surender Kumar & Goutham Sutradhar, Oxford &IBH Publishing Co. Pvt .Ltd., New Delhi, 1998
7. Principles of Metal Casting by Heine, Loper and Rosenthal, TMH, New Delhi, 1995
8. Metal Forming Processes by GR Nagpal, Khanna Publishers, New Delhi, 2000
9. Microfabrication and Nano manufacturing by Mark James Jackson, CRC Press, 2005
10. Nanofabrication by Z. Cui, , Springer, 2008
11. Introduction toNanoscienceand Nanotechnology by Gabor L. Hornyak, H.F. Tibbals, Joydeep Dutta and John J. Moore, CRC Press, Boca Raton, 2009

(MM113) OPTIMIZATION TECHNIQUES

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	Tut	Prac	Theory	Sess.	TW	Prac	Total	Lect	Tut	Prac	Total
4	0	2	60	40	25	25	150	4	0	1	5

OBJECTIVES OF THE COURSE

- To introduce basics of liner programming and non-liner programming techniques.
- To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems.

DETAILED SYLLABUS

1 INTRODUCTION

Introduction, Historical development, Engineering Application, Optimization Techniques, Classification.

2 CLASSICAL OPTIMIZATION TECHNIQUES

Basic Concepts of Optimization-Convex and Concave Functions, Necessary and sufficient conditions for Stationary Points; Optimization of one- dimensional Functions; Unconstrained Multivariable Optimization, Multivariable optimization with equality and inequality constraint.

3 LINEAR PROGRAMMING

Introduction, Linear Programming and its Applications; Simplex method Duality in linear programming, Decomposition Principle, Quadratic Programming.

4 NONLINEAR PROGRAMMING

Introduction, One- Dimensional Minimization Methods-Elimination methods Unrestricted Search, Exhaustive Search, Dichotomous search, Fibonacci method, Golden Section Method, Interpolation methods.

5 UNCONSTRAINED OPTIMIZATION TECHNIQUES

Introduction, Classification, Univariate method, Powell's pattern search method, Simplex Method, Cauchy's Method, Newton's Method.

6 CONSTRAINED OPTIMIZATION TECHNIQUES

Introduction, Classification, Technique of variable transformation, Penalty functions-Exterior penalty function, Interior penalty function, Lagrange multipliers, Augmented Lagrange Multiplier Method.

7 UNCONVENTIONAL OPTIMIZATION

Genetic Algorithms, Simulated Annealing, Particle swarm optimization, Ant colony Algorithms, Neural Network- Based Optimization, Fuzzy & Neuro-fuzzy algorithms technique.

LEARNING OUTCOMES

After successful completion of the course, student will be able to

- Apply basic concepts of mathematics to formulate an optimization problem.
- Analyse and appreciate variety of performance measures for various optimization problems.
- Learn efficient computational procedures to solve optimization problems. And use Matlab to implement important optimization methods.

REFERENCE BOOKS

1. Optimization theory & Applications / S.S. Rao / New Age International.
2. Optimization methods for engineers/ N.V.S. Raju/PHI publications..G.S.Beveridge and R. S. Schechter/ Optimization Theory and Practice.
3. G. V. Rekllaitis, A. Ravindran, and K. M. Ragsdell/ Engineering Optimization-Methods and Applications.
4. Deb Kalyanmoy/ Optimization for Engineering Design: Algorithms and Examples.
5. Unwubolu Godfrey C. and Babu B.V., "New Optimization Techniques in Engineering".

PRODUCT DESIGN AND DEVELOPMENT

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	Tut	Prac	Theory	Sess.	TW	Prac	Total	Lect	Tut	Prac	Total
4	0	2	60	40	25	25	150	4	---	1	5

OBJECTIVES OF THE COURSE

- To make the students Competence with a set of tools and methods for product design and development.
- To make students aware about the selection of some important parameters for a new product i.e. selection of material, selection of processes etc.
- To impart knowledge about the role of multiple functions in creating a new product (e.g. marketing, finance, industrial design, engineering, production).
- To discuss about various methods available for rapid prototyping and their fundamental capabilities.

DETAILED SYLLABUS

1 INTRODUCTION
Importance of product design, type of design, product definition, product specification, Phases of product development: conceptual, embodiment and detailed design, product and technology development cycle, concept generation and evaluation methods

2 MATERIAL SELECTION
Importance, classification, material performance characteristic, selection criteria, Ashby Material selection chart

3 PROCESS SELECTION
Importance, types of manufacturing processes, Sources of information, selection criteria, Material and Process selection Methods, Expert systems. Computer Database Approach, performance indices, decision matrix, AHP and fuzzy approach, introduction to material and process selection software

4 VARIOUS CONCEPTS OF DESIGN
Benchmarking, DFM, DFA, DFX, supplier involvement, robust design, Quality Function Deployment (QFD), Concurrent engineering

5 PRODUCT ANALYSIS AND PRODUCT ASSEMBLY
Mathematics of Times Value of Money Cost Comparison, Depreciation Taxes. Inflation, profitability of Investment and Investment Decision Analysis, Sensitivity Analysis. Methods of cost Estimates, Industrial Engineering Approach, parametric Approach, Introduction to Assembly Modeling. Top-Down and Bottom-Up Approaches of AM. Mating Conditions Representation Schemes. Generation of Assembly Sequences

6 PROTOTYPING
Product Development Cycle and Importance of Prototyping. Types of prototypes. Different Types of Generative Manufacturing process, i.e., Stereo lithography. FDM, SLS etc. Factors Concerning to RP: Consideration for Adoptions, Advantages, Accuracy and

Economic Consideration

LEARNING OUTCOMES

After successful completion of this course student will be able to

- Identify and analyse the product design and development processes in manufacturing industry.
- Define the components and their functions of product design and development processes and their relationships from concept to customer over whole product lifecycle.
- Analyse, evaluate and apply the methodologies for product design, development and management.
- Undertake a methodical approach to the management of product development to satisfy customer needs.
- Understand various rapid prototyping techniques and process principles along with factors affecting the process.

REFERENCE BOOKS

1. Product Design and Manufacturing by A.K.Chitale, R.C.Gupta, PHI
2. Product Design and Development by Ulirich Karl T. and Eppinger Steven D, McGraw Hill
3. Engineering Design by Dieter George E., McGraw Hill
4. Handboook of Product Design for Manufacturing by Bralla, James G, McGraw Hill

MECHANICAL VIBRATION

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	Tut	Prac	Theory	Sess.	TW	Prac	Total	Lect	Tut	Prac	Total
4	0	2	60	40	25	25	150	4	---	1	5

OBJECTIVES OF THE COURSE

- To introduced the importance of vibrations in mechanical machineries.
- To understand various vibratory systems, namely, two degree, multi degree,continuous systems and to develop the mathematical model for them.
- To learn the solution methods to obtain their responses of various vibratory systems.
- To understand the working principle and applications of various vibration measuring instruments.

DETAILED SYLLABUS

1 INTRODUCTION

Characterization of engineering vibration problems, Review of single degree freedom systems with free, damped and forced vibrations

2 TWO-DEGREE OF FREEDOM SYSTEMS

Principal modes of vibration coordinate systems, various two degree of freedom systems, coordinate coupling, vibration absorbers

3 MULTI-DEGREE FREEDOM SYSTEMS

Free vibration equation of motion, influence coefficient i) stiffness coefficient (ii) flexibility coefficient generalized coordinates ,Eigen-value problem, Close coupled and far coupled systems, Orthogonality of mode shapes, Modal analysis for free, damped and forced vibration systems, Approximate methods for fundamental frequency-Rayleigh's, Dunkerley's, Method of matrix iteration, Stodola and Holzer method

4 CONTINUOUS SYSTEMS

Transverse vibration of string, Longitudinal vibration of rods, Torsional vibration of shaft, Transverse vibration of beams, free and forced vibration of continuous systems, Effect of Rotary inertia and shear deformation , Vibration of plates

5 VIBRATION CONTROL AND MEASUREMENT

Control: Balancing of rotating machine, in-situ balancing of rotors, control of natural frequency introduction of damping, vibration isolation and vibration absorbers,

Measurement: FFT analyzer, vibration exciters, signal analysis, time domain and frequency domain analysis of signals, experimental modal analysis, machine conditioning and monitoring, fault diagnosis

6 TRANSIENT VIBRATIONS

Response to an impulsive, step and pulse input, Shock spectrum

7 NON-LINEAR VIBRATIONS

Non-linear systems, Undamped and forced vibration with non-linear spring forces, Self-excited, Stability

LEARNING OUTCOMES

Upon successful completion of this course the student will be able to;

- Develop and analyze the mathematical model of a two degree, multi degree and continuous systems.
- Measure and control the response like displacement, velocity, acceleration and frequency of the mechanical system using vibration measuring instruments.
- Understand and analyze the transient response and non-linear vibrations of the mechanical systems.

REFERENCE BOOKS

1. Theory and practice of Mechanical Vibrations J.S. Rao and K. Gupta New Age International
2. Mechanical Vibrations G.K. Groover Nem Chand & Brothers
3. Mechanical Vibration Practice V. Ramamurti Narosa Publications
4. Mechanical Vibrations V.P. Singh Dhanpat Rai & sons
5. Textbook of Mechanical Vibrations R.V. Dukkipati& J. Srinivas Prentice Hall of India
6. Theory of Vibrations with Applications, W. T. Thomson, CBS Publishers, Delhi
7. Fundamentals of Vibration, Leonard Meirovitch, McGraw Hill International Edison.
8. Mechanical Vibrations, J P Den Hartog, McGraw Hill
9. Mechanical Vibrations, A H Church, John Wiley & Sons Inc

(MM114) – RESEARCH METHODOLOGY AND IPR

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	Tut	Prac	Theory	Sess.	TW	Prac	Total	Lect	Tut	Prac	Total
1	0	2	---	---	100	---	100	1	0	1	2

OBJECTIVES OF THE COURSE

- The primary objective of this course is to develop a research orientation among the scholars and
- to acquaint them with fundamentals of research methods. Specifically, the course aims at introducing them to the basic concepts used in research and to scientific social research methods and their approach. It includes discussions on sampling techniques, research designs and techniques of analysis. Understand research problem formulation, analyze research related information, and follow research ethics.
- To develop an understanding of various research designs and techniques.
- To identify various sources of information for literature review and data collection.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasise the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular, Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

DETAILED SYLLABUS

1 **Unit 1**

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

2 **Unit 2**

Effective literature studies approaches, analysis Plagiarism, Research ethics

3 **Unit 3**

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

4 **Unit 4**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT

5 Unit 5

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications

6 Unit 6

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Bio logical Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs

LEARNING OUTCOME

- Develop understanding on various kinds of research, objectives of doing research, research process, research designs and sampling.
- Have basic knowledge on qualitative research techniques.
- Have adequate knowledge on measurement & scaling techniques as well as the quantitative data analysis.
- Have basic awareness of data analysis-and hypothesis testing procedures.
- Develop understanding of the basic framework of research process.
- Understand about the Property Rights, Licensing and respective tools.

REFERENCE BOOKS

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007
5. Mayall , "Industrial Design", McGraw Hill, 1992
6. Niebel, "Product Design", McGraw Hill, 1974
7. Asimov , "Introduction to Design", Prentice Hall, 1962
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in NewTechnological Age", 2016
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

(MM108) SEMINAR - I

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	**Tut**	**Prac**	**Theory**	**Sess.**	**TW**	**Prac**	**Total**	**Lect**	**Tut**	**Prac**	**Total**
0	1	0	---	---	50	---	50	---	1	---	1

- The students are required to prepare and present seminar on given topic.
- The students will undertake seminar work for the period of full semester. They may opt for theoretical work, works related to any software or even design/develop & fabricate small innovative product.
- They are supposed to prepare and submit a seminar report as a part of their term work and give presentation on their work. The faculty should monitor the students for their seminar work regularly every week. They are to be examined based on their work done throughout the semester, seminar report, presentation cum viva and/or demonstration of model if any.

(MM201) FINITE ELEMENT METHODS

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	Tut	Prac	Theory	Sess.	TW	Prac	Total	Lect	Tut	Prac	Total
3	0	4	60	40	25	25	150	3	0	2	5

OBJECTIVES OF THE COURSE

- To provide in-depth knowledge about the Finite element methods used to analyse complex structural problems. To provide basics of finite element analysis. Ability to analyse and solve problems in both familiar and unfamiliar situations including those in real-life contexts with better accuracy.

DETAILED SYLLABUS

1 INTRODUCTION

Introduction and basic concept of finite element method, General steps for finite element method, application of FEM, advantage of FEM, shape function, Types of elements, Potential energy approach, Rayleigh-Ritz method, Weighted residual method-Galerkin's method, principle of virtual work. Stiffness matrix, stiffness matrix for spring element, direct stiffness method, boundary conditions

2 1D STRUCTURAL PROBLEM

Natural and global co-ordinate systems, linear shape function, stress-strain and displacement relationship, stiffness matrix for bar element, load vector, Boundary condition, elimination approach and penalty approach, structural problems: Axial bar elements, Thermal effects in axial bar elements, Quadratic shape function, displacement, stress and strain for quadratic element, element stiffness matrix for quadratic element

3 2D STRUCTURAL PROBLEM

Principles for 2D problems- plane stress and plane strain, Constant Strain Triangular element – shape function, element stiffness matrix and equation, plane stress problem, Isoparametric formulation of quadrilateral element- shape function, element stiffness matrix, numerical integration method, examples

4 DEVELOPMENT OF TRUSS EQUATION

Transformation of vectors in two dimensions, Global stiffness matrix for bar arbitrarily oriented in the plane, stresses in truss element, truss element problems

5 DEVELOPMENT OF BEAM EQUATION

Beam stiffness matrix on Euler Bernoulli's beam theory, distributed loading, work equivalence method, Beam element with nodal hinge, beam element problems

6 DEVELOPMENT OF FRAME AND GRID EQUATION

Rigid plane frame, element stiffness matrix of frame element, plane frame examples,

grid element equation and example

7 SCALER FIELD PROBLEMES

Steady state heat transfer, one dimensional heat conduction, and one dimensional heat transfer in thin fin element

8 AXISSYMMETRIC ELEMENT

Introduction, formulation and modeling, applications

LEARNING OUTCOMES

- Ability to analyse and solve structural problems.
- Able to understand application of analysis software, e.g. Ansys
- Able to obtain solution of complex problems of engineering involve in real life situation.

REFERENCE BOOKS

1. Introduction to Finite Elements in Engineering", Tirupathi K. Chandrupatla and Ashok D. Belegundu Prentice Hall of India Private Ltd.
2. "A First Course in the Finite Element Method", D. L. Logan, Cengage Learning, Mc Graw Hill.
3. "CAD / CAM and Automation", FarazdakHaidery, Nirali Prakashan.
4. "Finite Element Analysis", P. Seshu,
5. "Finite Element Procedures in engineering analysis", K.J Bathe.
6. "An Introduction to Finite Element Methods", J. N. Reddy, Mc Graw Hill.
7. "The finite element methods in Engineering", S.S. Rao, Pergamon, New York.
8. "The Finite Element Method in Engineering science", O.C. Zienkowicz, Mc Graw Hill.

(MM202) COMPUTER AIDED MANUFACTURING

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	Tut	Prac	Theory	Sess.	TW	Prac	Total	Lect	Tut	Prac	Total
4	0	2	60	40	25	25	150	4	0	1	5

OBJECTIVES OF THE COURSE

- Understand the basic fundamentals of Computer Aided Manufacturing.
- To learn the part programming, importance of group technology, computer aided quality control, shop floor data control and automated material handling system.

DETAILED SYLLABUS

1 ESSENTIALS OF NC/CNC MACHINE TOOLS

Fundamentals and principles of NC/CNC Machine Tools: NC, CNC, DNC. Classification of NC/CNC Machine tools, Features of CNC Systems, Specification of CNC systems.

Components of NC/CNC system -Ball screws, Guideways, machine structure, drives and controls, Machine Control Unit, Transmission system, Drives and Feedback Devices, NC/CNC tooling etc.

Nomenclature of NC machine axes, CNC Control System, Automatic tool changer, Automatic Pallet Changer NC part programming, Punched tape and tape formats, NC words, Manual Part Programming for turning and machining centers

2 Flexible Manufacturing System (FMS)

Introduction of FMS, Need of FMS, General Considerations for FMS, Types of FMS,

Flexibilities and their measurements, various mathematical techniques for flexibility

Measurements. Manufacturing cells, cellular v/s flexible manufacturing, Application of Just in Time and Group Technology to FMS

3 AUTOMATED MATERIAL HANDLING SYSTEMS

Type of Material Handling System, Configuration, Equipment, Elements Automated Guided Vehicle (AGV), Automated Storage and Retrieval System (ASRS), Carousal System, scheduling of AGVs

4 COMPUTER INTEGRATED MANUFACTURING (CIM) SYSTEMS

Introduction of CIM, nature and types of manufacturing system, evolution of CIM, hardware and software for CIM, benefits, scope and needs, CIM wheel, elements of CIM and their role, Computer technology and manufacturing, database requirement, fundamentals of communication, concurrent engineering.

CAD/CAM Integration: - Activities involved, case studies, software requirements, hardware requirements, factory automation, implementation

5 Automatic Identification &Inspection :

Automatic Identification

Shop floor control – Factory data collection system, Bar code techniques, Computer for local area network.

Automated inspection

Basic principles and methods, Techniques for automated inspection– Contact and non-contact inspection methods in processes, Automated measuring methods –machine vision, optical inspection methods

LEARNING OUTCOMES

- Describe the use of Group technology, Flexible Manufacturing System and Automated material Handling and Inspection.
- Identify the various elements and their activities in the Computer Aided Manufacturing Systems.

REFERENCE BOOKS

1. Mikell P. Grover, Automation., Production Systems and Computer Integrated Manufacturing, Prentice Hall of India Pvt Ltd, 1995
2. A Troisky, Principles of Automatiopn and Automated Production, Mir Publ, 1971
3. C.RayAstaihe, Robots of Manufacturing automation, John Wiley and Sons, New York.
4. Numerical control and computer aided manufacturing – T.K.Kundra, P.N.Rao and N.K.Tewari –
5. Tata McGraw Hill Publishing Company Ltd.
6. Computer numerical control machines –P.Radhakrishnan ,New Central Book Agency
7. Flexible Manufacturing Cells and System -William. W. Luggen Prentice Hall, England Cliffs, NJ.
8. CAD, CAM and CIM – P. Radhakrishan, S. Subramaniyam, New Age International.
9. Mechatronics- Integrated Technologies for Intelligent Machines, A. Smaili and F. Mrad-Publisher- Oxford University Press
10. Vajpayee S. Kant, “Computer integrated Manufacturing” Prentice Hall of India, 1995.
11. CAD CAM by P.N Rao
12. Vinay Patel and P.M. Agrawal, “CNC- Fundamentals and Programming”, Charotar Publication.
13. Principles of Computer Aided Design and Manufacturing / Farid Amirouche / Pearson.
14. Computer Numerical Control Concepts and programming / Warren S Seames / Thomson.

15. Product manufacturing and cost estimation using CAD/CAE/ Kuang Hua Chang, Elsevier Publishers.

(MM209) HYDRAULIC AND PNEUMATIC SYSTEMS

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	Tut	Prac	Theory	Sess.	TW	Prac	Total	Lect	Tut	Prac	Total
3	0	4	60	40	25	25	150	3	0	2	5

OBJECTIVES OF THE COURSE

- Students shall be able to understand fluid power technologies, working principles of hydraulic pumps along with performance, different types of actuators and control valves used in hydraulic and pneumatic, purpose and operation of air filters, regulators, lubricators, dryers etc… and various methods of controlling of pneumatic cylinders

DETAILED SYLLABUS

1 FLUID POWER SYSTEM

Introduction, methods of power transmission, advantages of fluid power, applications of fluid power, types of fluid power system

2 BASIC PRINCIPLES OF HYDRAULICS

Basic terms and definitions in hydraulics, Pascal's law application, continuity equation, Reynold number, laminar and turbulent flow, Darcy-Weisback's equation, losses in pipe and pipe fittings

3 HYDRAULIC FLUIDS

Introduction, Fluid properties, requirements of hydraulic fluids, types and selection of hydraulic fluids

4 HYDRAULIC PUMPS

Introduction, basic elements of hydraulic system, pump classification, gear pump, vane pump, piston pump, pump performance, comparison of various hydraulic pumps

5 HYDRAULIC ACTUATORS

LINEAR ACTUATORS: Introduction, linear actuator classification, cylinder mounting methods, cylinder cushioning, cylinder force, velocity and power, cylinder dynamics, checklist for cylinder design

ROTARY ACTUATORS: Hydraulic motors, gear motor, vane motor, piston motor, motor performance

6 HYDRAULIC CONTROL VALVES

DIRECTION CONTROL VALVES: Introduction and classification, ports and position, valve symbol, valve actuation methods, poppet valves, rotary spool valves, sliding spool valves, two and three position valves, centre conditions, check valve, shuttle valve

PRESSURE CONTROL VALVES: Introduction, pressure relief valve - simple and compound type, pressure reducing valve - simple and compound type, Unloading valve, sequence valve, counterbalance valve, brake valve

FLOW CONTROL VALVE: Introduction, classification, fixed type flow control valve, adjustable type flow control valves,non-pressure compensated type and pressure compensated type flow control valve, speed control of a cylinder using flow control valve

7 HYDRAULIC ACCUMULATOR

Introduction and classification of hydraulic accumulators, dead weight type accumulator, spring loaded type accumulator, separator and non-separator type gas loaded accumulators, accumulator application circuits

8 HYDRAULIC CIRCUIT DESIGN AND MAINTENANCE

Design information required, selection of hydraulic cylinders, selection of hydraulic motors, selection of hydraulic control valves, selection of hydraulic filters, selection of hydraulic conduits, pump selection, reservoir, trouble shooting, maintenance and safety considerations in hydraulic circuits

9 INTRODUCTION TO PNEUMATIC CONTROL

Introduction, characteristics of compressed air, selection criteria for Pneumatic control system, Advantages and disadvantages of Pneumatic control, Basic structure of Pneumatic control system

10 COMPRESSED AIR PREPARATION

Various types of compressors for air preparation, Different types of air filters, Compressed air regulator, Compressed air lubricator

11 PNEUMATIC ACTUATORS

Single acting actuators, Various double acting actuators like actuators with cushion, Tandem actuators, Rod less actuators, Rotary actuators, cylinder seals

12 PNEUMATIC CONTROL VALVES

Use of directional control valves in Pneumatics, Symbolic representation of DCV, Types of DCV, Constructional details of DCV, Selection criteria of DCV, Flow control valves, Quick exhaust valve, shuttle valve, Two pressure valve, Time delay valve

13 CONTROLLING OF PNEUMATIC CYLINDERS

Direct control of single acting cylinders, Indirect control of single acting cylinders, Methods of checking end positions, speed control of cylinders, coordinated motion control

LEARNING OUTCOMES

On successful completion of the course, student will be able to;

- understand fluid power technologies, basic principles of fluid power and identify different applications, fluids and their important properties
- understand working principles of various types of hydraulic pumps and hydraulic and pneumatic actuators
- understand various type of control valves used in hydraulic and pneumatic and able to understand and prepare various hydraulic and pneumatic circuits

REFERENCE BOOKS

1. Fluid Power with Applications, Anthony Esposito, Pearson Education
2. Oil Hydraulics Systems - Principles and Maintenance, Majumdar S.R., Tata McGraw-Hill
3. Hydraulic and Pneumatic controls, Srinivasan.R, Vijay Nicole Imprints Pvt. Ltd
4. Hydraulics and Pneumatics, Andrew Parr, Jaico Publishing House
5. Hydraulic and Pneumatic controls, Shanmugasundaram.K, S. Chand & Co
6. Pneumatics Systems - Principles and Maintenance, Majumdar S. R., Tata McGraw-Hill
7. Industrial Fluid Power, D. S. Pavaskar, P. D. Sonawane, P. M. Chanegaonkar, R. V. Shetty,NishantPrakashan

(MM204) – RAPID PROTOTYPING AND TOOLING

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	Tut	Prac	Theory	Sess.	TW	Prac	Total	Lect	Tut	Prac	Total
4	0	2	60	40	25	25	150	4	0	1	5

OBJECTIVES OF THE COURSE

- To understand product development process, importance of prototyping and various processes available for rapid prototyping along with reverse engineering techniques
- To get knowledge about techniques for processing of CAD model for rapid prototyping an
- To understand about traditional tooling and rapid tooling, various methods to fabricate rapid tooling.

DETAILED SYLLABUS

1 INTRODUCTION

Product development cycle, Need for time compression in product development, Innovation process and blocks in creativity, influence of innovation on product development, Introduction to Prototyping, types of prototypes, Traditional Prototyping Vs. Rapid Prototyping (RP), Usage of RP parts, Generic RP process, Distinction between RP and CNC, other related technologies, Classification of RP

2 RAPID PRODUCT DEVELOPMENT- OVERVIEW

virtual prototyping and testing technology, Physical Prototyping and Rapid Manufacturing technologies and Synergic Integration Technologies

3 LIQUID BASED AND SOLID BASED RAPID PROTOTYPING SYSTEMS

Stereo lithography Apparatus (SLA), Fused deposition Modeling (FDM), Laminated object manufacturing (LOM) : Working Principles, details of processes, Products, materials, advantages, limitations and applications - Case studies

4 POWDER BASED RAPID PROTOTYPING SYSTEMS

Selective Laser Sintering (SLS), Direct Metal Laser Sintering (DMLS), Three Dimensional Printing (3DP), Laser Engineered Net Shaping, Selective Laser Melting, Electron Beam melting (EBM): Processes, materials, products, advantages, applications and limitations – Case Studies

5 CAD MODELLING AND DATA PROCESSING FOR RP

CAD model preparation, Data Requirements, Data formats (STL, SLC, CLI, RPI, LEAF, IGES, HP-GL, CT, STEP), Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation

6 REVERSE ENGINEERING

Forward engineering and reverse engineering, Basic concept of reverse engineering,

need of reverse engineering, Digitization techniques, Model Reconstruction, Data Processing for Rapid Prototyping, Reverse Engineering (RE) Methodologies and Techniques, Selection of RE systems, RE software, RE hardware, RE in product development

7 RAPID TOOLING

Conventional Tooling Vs. Rapid Tooling, Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect-Fabrication processes, Applications. Case studies - automotive, aerospace and electronics industries

LEARNING OUTCOMES

After successful completion of the course, student will be able to;

- Get knowledge about different rapid prototyping techniques and CAD modelling for RP technology
- Understand about the importance of reverse engineering and its application in engineering, medical and other fields
- Know about rapid tooling and its application in the field of industry for time compression

REFERENCE BOOK

1. Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing Gibson, I., Rosen, D.W. and Stucker, Springer, 2010
2. Rapid Tooling: Technologies and Industrial Applications by Hilton, P.D. and Jacobs, P.F, CRC press, 2005.
3. Rapid Prototyping: Principles and Applications in Manufacturing by Rafiq Noorani, John Wiley & Sons, 2006
4. Rapid Prototyping Technology: Selection and Application by Kenneth G. Cooper, CRC Press, 2001
5. Rapid prototyping: Principles and applications, second edition, Chua C.K., Leong K.F., and Lim C.S., World Scientific Publishers, 2003

MODELING AND SIMULATION

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	**Tut**	**Prac**	**Theory**	**Sess.**	**TW**	**Prac**	**Total**	**Lect**	**Tut**	**Prac**	**Total**
4	0	2	60	40	25	25	150	4	---	1	5

OBJECTIVES OF THE COURSE

- All the engineering systems work on certain scientific laws and principles which govern them. If mathematical models of those systems are prepared and analysed or simulated under probable service conditions, it's possible to know the behaviour of those systems. The objectives of this course are to,
- Familiarize students with the concept of mathematical modelling of various engineering systems,
- Learn that how to analyse or simulate those mathematical models, and
- Learn MATLAB and SIMULINK software tools for modelling and simulation.

DETAILED SYLLABUS

1 INTRODUCTION
Introduction to concept of system and environment, various types of systems i.e., Static and Dynamic systems, Continuous and discrete systems, linear and nonlinear systems etc., Introduction to modeling, Principles used in modeling. Types of models i.e., Mathematical models, Physical models, analog models and others, Estimation of model parameters

2 SIMULATION
Simulation techniques, experimental nature of simulation, numerical computation techniques, continuous system models; analog and hybrid simulation, Output data analysis for a single system, comparing alternative system configurations

3 STATISTICAL APPROACH
Statistical procedure for comparing real world observations with simulation output data, Generation of arriving processes, Verification and validation of simulation models

4 MONTE CARLO SIMULATION
Monte Carlo simulation and its application in queuing models and inventory models, Simulation of manufacturing and material handling system

5 CASE STUDIES
Mathematical modeling and simulation of various Mechanical and Electrical Systems

LEARNING OUTCOMES

After learning this course,

- Students would be familiar with the concept of mathematical modelling and simulation which will be useful for studying various engineering systems.
- They will Learn MATLAB and SIMULINK software tools for modelling and simulation.

REFERENCE BOOKS

1. Law A.M. & Kelton W.D. “Simulation Modeling and Ana lysis”, McGraw Hill Publication, 1991.
2. Jerry Banks, “Discrete event System simulation”, 2nd edition, Prentice Hall of India Ltd., 2000.
3. Geoffrey Gorden, “System Simulation”, 2nd edition, Prentice Hall of India Ltd., 2007.
4. Neelam Kavil K., “Computer Simulation and Modeling”, John Wiley & Sons, 1987.
5. Dr. D. S. Hira, “System Simulation”.
6. Allan Carrie, “Simulation of Manufacturing”, John Wiley & Sons.
7. Sunil Saigal, Stefan Thynell, Harold S. Morgan, Ken Chong, “Modeling and Simulation Based Life-Cycle Engineering”, Taylor and Francis, 2001.

MECHATRONICS IN MANUFACTURING SYSTEMS

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	**Tut**	**Prac**	**Theory**	**Sess.**	**TW**	**Prac**	**Total**	**Lect**	**Tut**	**Prac**	**Total**
4	0	2	60	40	25	25	150	2	---	1	5

OBJECTIVES OF THE COURSE

- To improve knowledge of electronics & its application with mechanical engineering
- To enhance knowledge about various types of sensors
- To enhance knowledge of controllers
- To understand behaviour of different types of machines which gives different types of mechanical output
- To understand different types of hydraulic & pneumatic systems
- To understand details of CNC machines and basics of robotics

DETAILED SYLLABUS

1 INTRODUCTION
Definition of Mechatronics, Mechatronics in manufacturing, products and design. Review of fundamentals of electronics

2 MECHATRONICS ELEMENTS
Data conversion devices, sensors, micro-sensors, transducers, signal processing devices, relays, contactors and timers

3 PROCESSORS /CONTROLLERS
Microprocessors, microcontrollers, PID controllers and PLCs

4 DRIVES AND MECHANISMS OF AN AUTOMATED SYSTEM
Drives: stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, and transfer systems

5 APPLICATIONS OF HYDRAULIC AND PNEUMATIC SYSTEMS
Hydraulic systems: flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps, Design of hydraulic circuits
Pneumatics: production, distribution and conditioning of compressed air, system components and graphic representations, design of systems

6 CNC TECHNOLOGY AND ROBOTICS
CNC machines and its maintenance, Industrial Robotics

LEARNING OUTCOMES

- Identify different types of Mechatronics application in manufacturing
- Identify & process the signal received from different types of sensors

- Use embedded systems in depth
- Different types of machine which gives different types of mechanical output
- Design different types of hydraulic & pneumatic systems
- Handle CNC machines

REFERENCE BOOKS

1. Boucher, T. O., “Computer automation in manufacturing - an Introduction”, Chapman and Hall, 1996.
2. HMT ltd. “Mechatronics”, Tata McGraw-Hill, New Delhi, 1988
3. Deb, S. R., “Robotics technology and flexible automation”, Tata McGraw-Hill, New Delhi, 1994.
4. Boltan, W., Mechatronics: electronic control systems in mechanical and electrical engineering, Longman, Singapore, 1999
5. Bradley, D.A., Dawson, D, Buru, N.C. and Loader, AJ, "Mechatronics ", Chapman and Hall
6. Bradley, D.A., Dawson, D, Buru, N.C. and Loader, AJ, "Mechatronics ", Chapman and Hall
7. Ramesh.S, Gaonkar, "Microprocessor Architecture, Programming and Applications” Wiley 1998.
8. Mechatronics- Ganesh S. Hegde, Published by University Science Press (An imprint of Laxmi Publication Private Limited)

TRIBOLOGY IN DESIGN

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	Tut	Prac	Theory	Sess.	TW	Prac	Total	Lect	Tut	Prac	Total
4	0	2	60	40	25	25	150	4	---	1	5

OBJECTIVES OF THE COURSE

- Concept of tribology basically helps engineers to develop machines with long life and improved performance. The objective of the course is to teach the basics of friction, wear andlubrication. This course also includes the study of measurement techniques of various tribometric characterizes. Moreover, the design and analysis of various commonly used bearings will also be discussed.

DETAILED SYLLABUS

1. **INTRODUCTION**
   Introduction to tribology, Introduction to bearings, properties of lubricants, viscosity index, effect of pressure and temperature on viscosity
2. **SURFACES, FRICTION AND WEAR**
   Topography of surfaces, Surface features, Surface interaction, Laws of friction, Theory of Friction, Types of friction, Friction properties of metallic and non-metallic materials, effects of friction, COF, friction reducing measures, Wear, causes of wear, types of wear, wear of different materials, effect of wear, steps of wear prevention
3. **LUBRICATION AND LUBRICANTS**
   Importance of lubrication, Lubrication principles, boundary lubrication, mixed lubrication, hydrodynamic lubrication, hydrostatic lubrication, Elastohydrodynamic lubrication, Types & Properties of Lubricants, SAE classification
4. **DESIGN AND ANALYSIS OF FLUID FILM BEARINGS**
   Introduction, Petroff's equation, Reynold's equation, mechanism of pressure development, plane-slider bearing, idealized journal bearing, step bearing, analysis of finite bearing, lubricant flow through a bearing, heat generation and lubricant temperature, design of journal bearing, design of hydrostatic bearings
5. **BEARING MATERIALS**
   Introduction, general requirements, different types of materials
6. **ROLLING ELEMENT BEARINGS**
   Geometry and kinematics, Contact stresses, Hertzian stress equation, Stresses and deflection, load capacity, Bearing life capacity and variable loads, prediction of fatigue life of a ball bearings, Lubrication

LEARNING OUTCOMES

After successful completion of this course student will be able

- To understand fundamentals of friction, wear and lubrication.

- To analyze and design various fluid film and rolling element bearings.
- To measure various tribometric characteristics experimentally.

REFERENCE BOOKS

1. Cameron A., “Basic Lubrication Theory”, Ellis Horwood Ltd., UK, 1981
2. Fundamentals of fluid film lubrication by Hamrock, Schmid, Jacobson
3. Tribology in industries by Sushil Kumar Srinvastava, .Chand& Company Ltd., 2011
4. Tribology by H.G. Phakatkar and R.R. Ghorpade, Nirali Prakashan.
5. Halling J. (Editor), “Principles of Tribology “, Macmillian, 1984.
6. Williams J.A., “Engineering Tribology”, Oxford Univ. Press, 1994.
7. Neale, M.J., “Tribology Hand Book”, Butterworth Heinemann, 1995.
8. Stolarski T.A., “Tribology in Machine Design”, Industrial Press, 1990.
9. Introduction to tribology of bearings by Majumdar,B. C., S. Chand & Company Ltd.,2010.
10. Fundamental of tribology by Basu, Sengupta and Ahuja, PHI Learning pvt.ltd., 2012.

(MM211) ROBOTICS

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	Tut	Prac	Theory	Sess.	TW	Prac	Total	Lect	Tut	Prac	Total
4	0	2	60	40	25	25	150	4	0	1	5

OBJECTIVES OF THE COURSE

- To Know about basics of robotics to understand about the various types of robot configuration with their applications in industries
- To apply the concept of DH convention for kinematics of manipulator
- To study about the drives and sensors used in Robots
- To know about various types of grippers and their design for robot
- To understand about various control elements of robotic and programming of robot

DETAILED SYLLABUS

1 INTRODUCTION

Automation and Robotics, Robot anatomy, robot configuration, motions joint notation, work volume, robot drive system, control system and dynamic performance, precision of movement

2 CONTROL SYSTEM AND COMPONENTS

Basic concept, robot activation and feedback components, Positions and velocity sensors, Linear and rotary actuators and control valves, power transmission system

3 MOTION ANALYSIS AND CONTROL

Manipulator kinematics, position representation forward transformation, homogeneous transformation, manipulator path control, robot dynamics, configuration of robot controller

4 END EFFECTORS

Grippers-types, operation, mechanism, force analysis, tools as end effector, consideration in gripper selection and design

5 ROBOT SENSORS

Desirable features, tactile, proximity and range sensors, uses sensors in robotics, Robotic vision system, Image grabbing, Image processing and analysis, Image segmentation, Pattern recognition, Training of vision system

6 ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

Methods of Robot Programming, Characteristics of task level languages lead through programming methods, Motion interpolation, Artificial intelligence, Basics, Goals of

artificial intelligence, AI techniques, Problem representation in AI, Problem reduction and solution techniques, Application of AI and ES in Robots

7 ROBOT CELL DESGIN AND CONTROL

Robot cell layouts-Robot centered cell, In-line robot cell, Considerations in work design, safety in robotics, Work and control, Inter locks, Error detection, Work cell controller

8 ROBOT APPLICATIONS AND RECENT TRENDS

Material transfer, Machine loading/unloading. Processing operation, Assembly and Inspection, Multi-axis robots, intelligent robots

9 PROGRAMABLE LOGIC CONTROLLER

Introduction to PLC, Programming a PLC, Logic Functions, Input & Output Modules,PLCProcessors, PLC Instructions, Documenting a PLC System, Timer & Counter Instructions, Comparison& Data Handling Instructions, Sequencing Instructions, Mask Data Representation, Typical PLCProgramming Exercises for Industrial Applications.

LEARNING OUTCOMES

After the successful completion of the course, student will be able to,

- understand different types of robot configuration and elements of robotic system
- Grasp distinctive knowledge of sensors, actuators and control system of robotics
- Understand different types of end effectors and design for the same.
- Know about basics of robot programming and PLC programming

REFERENCE BOOKS

1. Introduction to Robotics Analysis, Systems, Applications by Saeed B Niku PHI.
2. A Robot Engineering text book by MoshenShahinpoor, Harper and Row Publishers, NY.
3. Industrial Robotics by Mikell Groover, McGraw Hill Publications
4. Intro to Robotics, Mechanics and Control by John J Craig, Pearson Education
5. Fundamentals of Robotics – Analysis and Control, Robert J Schilling, PHI.
6. Industrial Robots by Ganesh S Hegde – Laxmi Publications.
7. Robotic technology, Principles and practice – Werner G Holz book – Van Nostrand Reinhold Co.NY.
8. Robotic Engineering – An Integrated Approach by Richard D Klaffer, Thomas A Chmielewski, Michael Negin – PHI.

DESIGN OF MATERIAL HANDLING EQUIPMENTS

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	**Tut**	**Prac**	**Theory**	**Sess.**	**TW**	**Prac**	**Total**	**Lect**	**Tut**	**Prac**	**Total**
4	0	2	60	40	25	25	150	4	---	1	5

OBJECTIVES OF THE COURSE

- To know basics of material handling systems including selection of equipment
- Industrial requirements to design appropriate systems to move goods, materials, and other industrial goods between points are addressed in this subject.
- Movement principles, frequency, and type of movements are studied in light of reducing the overall cycle time, with due consideration on economics.

DETAILED SYLLABUS

1 INTRODUCTION
Objectives of material handling systems; basic principles, classification, selection of material handling equipment, characteristics and applications, parameters affecting service

2 BULK MATERIAL HANDLING PLANTS AND CONVEYOURS
Introduction to bulk material handling plants and system, bulk materials and their characteristics, belt conveyors, methods of feeding/loading belt conveyor, types of belts, design requirement in belt selection, design of idlers and pulleys, belt cleaning devices

3 DESIGN OF HOISTS
Design of hoisting equipment, fibrous ropes, wire ropes, design of pulley systems, design of forged hooks and eye hooks, Bucket elevators: design of loading and bucket arrangements, design of fork lift trucks

4 CRANES
Types of cranes, Structural analysis of various types of cranes, stability of cranes

5 MISCELLANEOUS
Unit load handling, Palletizing, Packaging, Types of storages and packaging

LEARNING OUTCOMES

After learning the course the students should be able to:

- Understand the flow and type of movement of industrial goods.
- Apply general rules for the type of movement and identify the appropriatematerial handling systems to suit the said requirement.
- Design of material handling system.

REFERENCE BOOKS

1. Materials Handling Equipments by N. Rudenko - Peace Publishers
2. Material handling equipment by M. P. Alexandrov - MIR Publisher, Moscow
3. Material handling by Y. I. Oberman - MIR Publisher, Moscow
4. Conveyors and Related Equipments by Spivakowsky - Peace Publishers
5. Conveying Machines by Spivakowsky and V. Dyachke - MIR Publishers
6. Belt Conveyors for Bulk Materials (2nd Ed) by Conveyor Equipment Manufacturers Association

ADVANCED TOOL DESIGN

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	Tut	Prac	Theory	Sess.	TW	Prac	Total	Lect	Tut	Prac	Total
4	0	2	60	40	25	25	150	4	---	1	5

OBJECTIVES OF THE COURSE

- To impart the fundamentals notions of the different tooling elements including their applications and their capabilities
- To provide exposure to systematic methods for solving the problems of designing various tooling elements like cutting tools, jigs and fixtures and dies

DETAILED SYLLABUS

1 INTRODUCTION TO TOOL DESIGN

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

2 DESIGN OF CUTTING TOOLS

Single Point cutting tools: Milling cutters, Drills, Selection of carbide steels – Determination of shank size for single point carbide tools, determining the insert thickness for carbide tools, various heat treatments

3 DESIGN OF JIGS AND FIXTURES

Basic principles of location and clamping: Locating methods and devices, Jigs-Definition Types, General considerations in the design of Drill jigs, Drill bushing, Methods of Construction. Fixtures-Vice fixtures, Milling, Boring Lathe Grinding fixtures

4 DESIGN OF SHEET METAL BLANKING AND PIERCING DIES

Fundamentals of Die cutting operation, Power press types, General press information, Material Handling equipment, Cutting action in Punch and die operations. Die clearance, Types of Die construction. Die design fundamentals-Banking and piercing die construction, pilots, stripper and pressure pads presswork material, Strip layout, Short run tooling for piercing

5 DESIGN OF SHEET METAL BENDING, FORMING AND DRAWING DIES

Bending dies, drawing dies, forming dies, drawing operations, Variables that effect metal flow during drawing. Determination of blank size, Drawing force, Single and double action draw dies

6 TOOL DESIGN FOR CNC MACHINE TOOLS

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

LEARNING OUTCOMES

After the successful completion of the course students will be able to

- Understand various challenges and requirements of tooling elements in industries
- Design tooling elements like cutting tools, jigs and fixtures and dies
- Understand different tooling arrangement for CNC machine and design fixtures used in CNC machine

REFERENCE BOOKS

1. Cyrll Donaldson, George H. LeCain, V.C. Goold, "Tool Design", Tata McGraw Hill Publishing Company Ltd., 2000.
2. E.G.Hoffman," Jig and Fixture Design", Thomson Asia Pvt Ltd, Singapore, 2004
3. Prakash Hiralal Joshi, "Tooling data", Wheeler Publishing, 2000
4. Venkataraman K., "Design of Jigs, Fixtures and Presstools", TMH, 2005
5. Haslehurst M., "Manufacturing Technology", The ELBS, 1978
6. Sharma, P.C., "Machine Tool and Tool Design ", S Chand Company. 2004
7. Mehta N.K., "Machine Tool Design", Tata McGraw Hill, 1989.

ARTIFICIAL INTELLIGENCE

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	Tut	Prac	Theory	Sess.	TW	Prac	Total	Lect	Tut	Prac	Total
4	0	2	60	40	25	25	150	4	---	1	5

OBJECTIVES OF THE COURSE

- Students can able to understand emerging technology of Artificial intelligence theory, Mathematical Background, programming, and application to a different domain of Mechanical engineering like robotics, manufacturing system, and advanced design and simulation algorithm.

DETAILED SYLLABUS

1 CONCEPT OF AI

Approaches, Foundations of A.I.

Problem Formulation: Problem solving agents, Components of problem definition, defining the problem as state space approach, Problem characteristics, Production System, searching for solutions, forward and backward reasoning, means end analysis, Graphs and trees, measuring problem solving performance

Search Strategies: a)Uninformed (blind) search- breadth first, depth first, and their variations, avoiding repeated states; b) Informed (heuristic) search- heuristic function, Generate and test, Best first search, A* search, Local search algorithms- Hill climbing, Simulated annealing, Branch and bound and Local beam search

2 AI PROGRAMMING LANGUAGES

Basic of LISP, Numbers ,Lists ,Arithmetic , Strings and Characters ,Symbols ,Packages, Defining New Functions, Conditional Expressions, Recursion, Input/Output, Assignment, Iteration, Structures and The Type System, Arrays, Hash Tables, And Property Lists, Macros

3 ARTIFICIAL NEURAL NETWORKS: FUNDAMENTALS AND MODELS

Introduction, or how the brain works The neuron as a simple computing element, The perceptron, Multilayer neural networks, Accelerated learning in multilayer ,neural networks, The Hopfield network, Bidirectional associative memory, Self-organising neural networks

4 FUZZY SYSTEMS

Introduction, Fundamentals of Fuzzy Sets, Fuzzy Relations, Fuzzy Logic, Fuzzy rules, Fuzzy Control. Fuzzy Modeling and applications

Hybrid Systems: Neuro-fuzzy systems, ANFIS: Adaptive Neuro-Fuzzy Inference System

5 GENETIC ALGORITHM

Introduction, Computer implementation of Genetic algorithm, Data Structures, Reproduction, Cross over and Mutation. Time to reproduce and time to Cross Mapping objective function to fitness, form, Fitness scaling. Applications of genetic algorithm

6 AI IN ROBOTICS

State space search, path selection, AND-OR graphs, means end analysis in a robotic

problem, robot problem solving as a production system, robot learning and task planning, symbolic spatial relationship, obstacle avoidance, graph planning

LEARNING OUTCOMES

- At the completion of the syllabus, students can gain proficiency in artificial intelligence algorithm design, coding, and practical application to real-life problems. The student will able to implement AI concepts in future research or enhance their career in the endless possibility of AI-related industries.

REFERENCE BOOKS

1. Introduction to Artificial intelligence By Eugene Charniak, Drew McDermott Addison Wesley
2. Artificial Neural Networks- B.Yegnanarayana, PHI, 1999.
3. Genetic Algorithms in search, Optimization & Machine Learning by David E Goldberg-Addison wesley
4. Artificial Intelligence, Elaine Rich, Kevin Knight, S. Nair, McGraw Hill Publishing Company Ltd
5. Artificial Intelligence- A new synthesis. N.J. Nilsson, Morgan kaufmann Publishers Inc., 1998.
6. Artificial Intelligence and Design of Expert Systems – C.F. Luger & W.A. Stubblefeild, Addison-Wesley.
7. Introduction to Artificial Neural Systems – Jacek M. Zurada, Jaico Publishing House, 2001.
8. Neural Network – Simson Haykin, Macmillan Publication, 1994.
9. Fuzzy Set Theory & its Applications – H.J.Zimmermann, Allied Publishers Ltd, 1996.
10. Stuart Russel, Peter Norwig (2003), “Artificial Intelligence : A Modern Approach” 2/e, (Pearson Education)
11. Dan W. Patterson (1999), “Introduction to Artificial Intelligence and Expert Systems” (7th Indian Reprint) (EEE) (Prentice Hall of India)
12. Groover, Weiss, Nagel, Audrey, “Industrial Robotics- Technology, Programming and Applications””, (McGraw Hill)
13. Fu, Gonzalea and Lee, “Robotics: Control, Sensing, Vision and Intelligence”, (McGraw Hill)
14. Shapiro, Stuart Charles, ‘’Common LISP: an interactive approach’’, Computer Science Press, An imprint of W. H. Freeman and Company
15. David S. Touretzky ‘’COMMON LISP: A Gentle Introduction to Symbolic Computation’’, The Benjamin/Cummings Publishing Company,Inc.

(MM210) SEMINAR - II

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	**Tut**	**Prac**	**Theory**	**Sess.**	**TW**	**Prac**	**Total**	**Lect**	**Tut**	**Prac**	**Total**
0	1	0	---	---	50	---	50	---	1	---	1

- The students are required to prepare and present seminar on given topic.
- The students will undertake seminar work for the period of full semester. They may opt for theoretical work, works related to any software or even design/develop & fabricate small innovative product.
- They are supposed to prepare and submit a seminar report as a part of their term work and give presentation on their work. The faculty should monitor the students for their seminar work regularly every week. They are to be examined based on their work done throughout the semester, seminar report, presentation cum viva and/or demonstration of model if any.

(MM301) DISSERTATION - I

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	**Tut**	**Prac**	**Theory**	**Sess.**	**TW**	**Prac**	**Total**	**Lect**	**Tut**	**Prac**	**Total**
0	0	20	---	---	125	225	350	---	---	10	10

- The students are required to do their dissertation work in their field of interest. The students will go through this work for full semester. They are supposed to submit a dissertation report and give presentation on their work progress at the end of the semester.

(MM302) SEMINAR - I

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	**Tut**	**Prac**	**Theory**	**Sess.**	**TW**	**Prac**	**Total**	**Lect**	**Tut**	**Prac**	**Total**
0	2	0	---	---	50	---	50	---	2	---	2

- The students are required to prepare and present seminar on given topic.
- The students will undertake seminar work for the period of full semester. They may opt for theoretical work, works related to any software or even design/develop & fabricate small innovative product.
- They are supposed to prepare and submit a seminar report as a part of their term work and give presentation on their work. The faculty should monitor the students for their seminar work regularly every week. They are to be examined based on their work done throughout the semester, seminar report, presentation cum viva and/or demonstration of model if any.

(MM401) DISSERTATION - II

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	**Tut**	**Prac**	**Theory**	**Sess.**	**TW**	**Prac**	**Total**	**Lect**	**Tut**	**Prac**	**Total**
0	0	20	---	---	150	300	450	---	---	10	10

- The students are required to carry forward their dissertation work done in semester III in their field of interest. The students will go through this work for full semester. They are supposed to submit a final dissertation report and give presentation on their completed dissertation work at the end of the semester.

(MM402) SEMINAR - II

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	**Tut**	**Prac**	**Theory**	**Sess.**	**TW**	**Prac**	**Total**	**Lect**	**Tut**	**Prac**	**Total**
0	2	0	---	---	50	---	50	---	2	---	2

- The students are required to prepare and present seminar on given topic.
- The students will undertake seminar work for the period of full semester. They may opt for theoretical work, works related to any software or even design/develop & fabricate small innovative product.
- They are supposed to prepare and submit a seminar report as a part of their term work and give presentation on their work. The faculty should monitor the students for their seminar work regularly every week. They are to be examined based on their work done throughout the semester, seminar report, presentation cum viva and/or demonstration of model if any.