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SHIVAJI UNIVERSITY, KOLHAPUR.

Proposed Programme Structure

of

(M.E. CAD/CAM)

Semester – I to IV

To be introduced from the academic year 2014-15
(i.e. from July 2014) Onwards

(Subject to the modifications made from time to time)

SHIVAJI UNIVERSITY, KOLHAPUR

STRUCTURE OF M.E. (CAD/CAM) SEMISTER Ito IV

WITH EFFECTIVE FROM THE ACADEMIC YEAR 2014-15

SEMESTER I

Sr. No.	Subject	L	TUT	P	Total	TP	TW	OE	POE	Total
1	Design of Experiments & Research Methodology	3	1	-	4	100	25	-	-	125
2	Finite Element Analysis	3	1	--	4	100	--	--	--	100
3	Micro Electro-Mechanical Systems	3	--	-	3	100	--	--	--	100
4	Computer Aided Manufacturing	3	1	--	4	100	--	--	--	100
5	Elective I	3	--	2	5	100	25	---	--	125
6	CAD/CAM Laboratory I	--	--	2	2	--	50	25	--	75
7	Instrumentation and Control Lab	--	--	2	2	--	50	25	--	75
8	Seminar I	--	2	--	2	---	25	--	---	25
		15	**5**	**6**	**26**	**500**	**175**	**50**	**--**	**725**

L: Lecture,TUT:Tutorial P: Practical,TP:Theory Paper,T/W:Term Work POE/OE: Practical/ Oral Exam

UNLESS SPECIFIED THE THEORY EXAMINATION DURATION WILL BE OF 03 HOURS.

[Note: - Examination scheme and term work marks strictly as per above structure]

SHIVAJI UNIVERSITY, KOLHAPUR

STRUCTURE OF M.E. (CAD/CAM) SEMISTER I to IV

WITH EFFECTIVE FROM THE ACADEMIC YEAR 2014-15

SEMESTER II

Sr. No.	Subject	L	TUT	P	Total	TP	TW	OE	POE	Total
1	Product Life Cycle management	3	-	2	5	100	25	-	-	125
2	Advanced Mechanics of Materials	3	1	--	4	100	25	--	--	125
3	Automation & Robotics	3	1	--	4	100	25	--	--	125
4	Design Optimization Techniques	3	--	--	3	100	--	--	--	100
5	Elective II	3	1	--	4	100		---	--	100
6	CAD/CAM Lab II	-	--	2	2	--	25	25	--	50
7	Simulation and Analysis Lab	--	--	2	2	--	25		--	25
8	Seminar II	--	2	-	2	---	25	--	---	25
9	Comprehensive Viva	--	--	--	--	--	--	50	--	50
		15	**5**	**6**	**26**	**500**	**150**	**75**	**--**	**725**

L: Lecture, TUT: Tutorial P: Practical,TP:Theory Paper,T/W:Term Work P/O: Practical/ Oral Exam

Sr. No.	Elective I	Elective II
1	Advanced Design Engineering	Nano Technology
2	Advanced Tool Design	Industrial Product Design
3	Design of Hydraulic and Pneumatic Systems	Computational Fluid Dynamics.
4	Mechatronic System Design	Reliability Engineering

UNLESS SPECIFIED THE THEORY EXAMINATION DURATION WILL BE OF 03 HOURS.

[Note: - Examination scheme and term work marks strictly as per above structure]

SHIVAJI UNIVERSITY, KOLHAPUR

STRUCTURE OF M.E. (CAD/CAM) SEMISTER I to IV

WITH EFFECTIVE FROM THE ACADEMIC YEAR 2014-15

SEMESTER III

Sr. No.	Subject	L	TUT	P	Total	TP	TW	OE	POE	Total
1	Mini Project	--	-	-	--	--	50	50	-	100
2	# Dissertation Phase I	--	--	4	4	--	50	50	--	100
		--	**---**	**4**	**4**	**--**	**100**	**100**	**--**	**200**

SEMESTER IV

Sr. No.	Subject	L	TUT	P	Total	TP	TW	OE	POE	Total
2	# Dissertation Phase II	--	--	4	4	--	100	100	--	200
		--	**---**	**4**	**4**	**--**	**100**	**100**	**--**	**200**

For Seminar I & Seminar II, work load will be for two students.

Note: A Mini project in related area to be undertaken and completed during vacationafter Semester-II. The report shall be submitted and assessed at the beginning of the Semester-III.

 # For Dissertation Phase I & Dissertation Phase II, work load will be for one student.

[Note: - Examination scheme and term work marks strictly as per above structure]

M.E. (CAD/CAM) Semester-I

1. DESIGN OF EXPERIMENTS AND RESEARCH METHODOLOGY

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs / Week	Theory Paper: 100 marks
Tutorial: 1 Hr. / week	Term Work: 25 marks

1. Design of Experiments (DOE): Objectives, strategies, Factorial experimental design, Designing engineering experiments, basic principles- replication, randomization, blocking, Guidelines for design of experiments, process of DOE, **Simple Comparative Experiments-** Basic statistical concepts, random variable, sample mean and variance, degrees of freedom, standard normal distribution, statistical hypothesis, Two sample *t*test-value, Confidence intervals, Paired comparison. **(6)**

2. A) Single Factor Experiment: Analysis of Variance (ANOVA) for fixed effect model; Total treatment and error sums of squares, Decomposition of total sum of squares, ANOVA for Randomized complete block design to control effects of nuisance factors.

B) Two factor Factorial Design: Basic definitions and principles, main effect and interaction, response surface and contour plots, Blocking, General arrangement for a two-factor factorial design; Models- Effects, means and regression,

(8)

3. Taguchi Techniques for Experimental Design: Taguchi loss function, Average loss, nominal-the-best, smaller-the-best, larger-the-best, design process steps, selection of factors affecting- methods, factor levels, Test strategies- Full factorial experiment, fractional factorial experiment, Orthogonal arrays and their selection; Interaction effects, **Parameter Design**- Control and noise factors and parameter design, signal to noise ratio, types, parameter design strategy, tolerance design, robust design.

(6)

4. Research: Definition of research, Applications of research and types, Research process and steps in it, Deductive and inductive reasoning; **Validity**-conclusion, internal, construct and external; Problem Solving – Types, Process and Approaches – Logical, Soft System and Creative; Creative problem solving process, Development of Creativity, Group Problem Solving Techniques for Idea Generation – Brain storming and Delphi Method.

(6)

5. Literature review- Need, Procedure- Search for existing literature, Review the literature selected, Develop a theoretical and conceptual framework, Writing up the review, **Formulating a research problem**: Sources, Considerations, Steps in formulation of a problem, formulation of objectives, **Definition of variables –** Concepts, indicators and variables, Types of variables, Types of measurement scales, **Constructing the Hypothesis-** Null(Research) and alternative, one-tailed and two-tailed hypotheses, Hypothesis testing, errors in testing. **(5)**

6. A) Research Modeling: Types of Models, Model building and stages, Data consideration and testing, Heuristic and Simulation modeling, Data collection methods, Surveys-types and method selection.

B) Research Proposal: Contents-Preamble, the problem, objectives, hypothesis to be tested, study design, setup, measurement procedures, analysis of data, organization of report; Displaying data- tables, graphs and charts, **Writing a research report-**Developing an outline, Key elements- Introduction, Methods, Measurement section, Design& procedure section, Results, conclusion section, Referencing of books and research papers, Report Writing- Prewriting considerations, Thesis writing, Formats of report writing, Formats of publications in Research journals.

(9)

TERM WORK:

1. Minimum three exercises using a statistical software for hypothesis testing involving Two sample *t*-test, *P*-value, Confidence Intervals, Paired comparison

2. Design of an experiment for an engineering application with two variables and 2 to 3levels for the variables and analysis of variance for it- a case study.

3. One exercise on design of experiment using Taguchi technique and orthogonal arrays

4. Collection of research papers (at least five) published in referred / peer reviewed journals on any **single** research area related to mechanical engineering, preparing and presenting a review. (The papers collected shall be different for each student.)

REFERENCE BOOKS:

1. Krishnaswamy, K. N., Sivakumar, AppaIyer and Mathirajan, M. (2006), Management Research Methodology: Integration of Principles, Methods and Techniques (Pearson Education, New Delhi)
2. Montgomery, Douglas C. (2007) – Design & Analysis of Experiments, 5/e. (New Delhi,Wiley Student Edition, Wiley India Pvt. Ltd.) ISBN: 978-81-265-1048-1
3. Montgomery, Douglas C. & Runger, George C. (2007) – Applied Statistics & Probability for Engineers, 3/e, . (New Delhi, Wiley Student Edition, Wiley India Pvt. Ltd.), ISBN: 978-81-265-1424-3
4. Ranjit Kumar, (2006), Research Methodology- A Step-By-Step Guide for Beginners,(Pearson Education, Delhi) ISBN: 81-317-0496-3
5. Trochim, William M.K., (2003), 2/e, Research Methods, (Biztantra, Dreamtech Press,New Delhi), ISBN: 81-7722-372-0
6. Kothari, C.K., (2004), 2/e, Research Methodology- Methods and Techniques, (NewAge International, New Delhi)
7. Ross, Philip J. (1996), 2/e, Taguchi Techniques for Quality Engineering, (McGraw Hill,New York)
8. Besterfield, Dale H. (2005), 3/e, Total Quality Management, (Pearson Education, NewDelhi)

9. Dean, Angela & Voss, Daniel, - Design & Analysis of Experiments, (1999), (Springer Verlag), ISBN: 0-387-98561-1
10. Panneerselvam – Research Methodology, (PHI), ISBN: 81-203-2452-8
11. Hinkelmann&Kempthorne – Design & Analysis of Experiments, Vol. I- Introduction toExperimental Design, (2005), (John Wiley & Sons)
12. Hinkelmann&Kempthorne – Design & Analysis of Experiments, Vol. II- AdvancedExperimental Design, (2005), (John Wiley & Sons)
13. Richard L. Shell & Ernest L. Hall - Handbook of Industrial Automation,– (Marcel Decker Inc.)

M.E. (CAD/CAM) Semester – I

2. FINITE ELEMENT ANALYSIS

Teaching Scheme: **Examination Scheme:**
Lectures: 3 Hrs/ Week Theory Paper: 100 marks

1. Introduction to Finite Element Method: Basic Concept, Historical Background, Engineering applications, general Description, comparison with other methods. **(3)**

2. Integral Formulation and Variation Methods: Need for weighted-integral forms, relevant mathematical concepts and formulate, weak formulation of boundary value problems, variational methods, Rayleigh-Ritz method and weighted residual approach.
(4)

3. Finite Element Techniques: Module boundary value problem, finite element decartelization, element shapes, sizes and node locations, interpolation functions, derivation of element equations, connectivity, boundary conditions, FEM solutions, post processing, Compatibility and completeness requirements, convergence criteria, higher order and isoparametric elements, natural coordinates, Lagrange and Hermit Polynomials.
(7)

4. Applications to Solid and Structural Mechanics Problems: External and internal equilibrium equations, one-dimensional stress-strain relations, plane stress and strain problems, axis symmetric and three dimensional stress strain problems, strain displacement relations, boundary conditions compatibility equations, analysis of trusses, frames and solid of revolution, computer programs.
(7)

5. A) Applications to Heat Transfer Problems: Variational approach, Galerikn approach, one dimensional and two dimensional steady state problems for conduction, convection and radiation, transient problems.

B) Applications to Fluid Mechanics Problems: Inviscid incompressible flow, potential function and stream function formulation, incompressible viscous flow, stream function, velocity-pressure and streamfunction voracity formulation, solution of incompressible and compressible fluid film lubrication problems, Additional Applications: Steady state and transient field problem.
(11)

6. Parameters Affecting Accuracy of the FEA results: How to validate and check accuracy of FEA results? Computational accuracy: strain energy norm, residuals, Reaction forces and moments; convergence test, Average and unaverage stress difference. Correlation with actual testing: strain gauging-stress comparison; natural frequency comparison; Dynamic response comparison, temperature and pressure distribution comparison. **(7)**

REFERENCE BOOKS:

1. Finite Element Analysis – Theory & Practice by Fagan (Longman Scientific &Technical)
2. Fundamentals of Finite Element Analysis, David Hutton, TMH
3. Finite Element Method versus Classical Methods,- H.S. GovindaRao, New Age International Publishers
4. An Introduction to Finite Element Analysis by J. N. Reddy, (Tata McGraw- Hill Pub.Co.)
5. The Finite Element Method: Linear Static and Dynamic Finite Element Analysis by T. J. R. Huges, Dover Publications, 2000
6. Finite Element Procedures by Bathe, Prentice-Hall.
7. Finite Element Analysis by P. Seshu (PHI)
8. Practical Finite Element Analysis - NitinGokhale (Finite To Infinite, Pune)
9. Introduction to Finite Elements in Engineering by Chandrupatala and Belegundu.
10. Concepts & Application of Finite Element Analysis by R. D. Cook, D. S. Malku,(John Wiley & Sons)
11. The Finite Element Methods, 3/e –Sienkiewicz(Tata McGraw Hill).

M.E. (CAD/CAM) Semester-I

3. MICRO-ELECTRO-MECHANICAL SYSTEMS (MEMS)

Teaching Scheme: **Examination Scheme:**
Lecturers: 3 Hrs/ Week Theory: 100 Marks

1. Introduction: Micro-Electro-Mechanical Systems (MEMS), Microsystems and their products, miniaturization, applications, mechanical MEMS, thermal MEMS, micro-optoelectro-mechanical systems, magnetic MEMS, radio frequency (RF) MEMS. **(4)**

2. Micro Fabrication Processes & Materials: Materials for MEMS, substrate and wafers, silicon as a substrate material, crystal structure, single crystal and polycrystalline, mechanical properties, silicon compounds, silicon piezo-resistors, gallium arsenide, quartz, piezo-electric crystals, polymers, packaging materials; Fabrication processes, Bulk micro manufacturing, photolithography, photo resists, structural and sacrificial materials, X-ray and electron beam lithography, Thin film deposition spin coating, thermal oxidation, chemical vapour deposition (CVD), electron beam evaporation, sputtering; Etching, wet etching, dry etching; Surface micromachining, bulk vs. surface micromachining; LIGA process and applications. **(10)**

3. Micro Sensors & Actuators: Sensing and actuation, Chemical sensors, Optical sensors, Pressure sensors, Thermal sensors – thermopiles, thermistors, micro-machined thermocouple probes, thermal flow sensors, MEMS magnetic sensor, magnetic actuators – optical switches and bidirectional micro actuators, Piezoelectric material as sensing and actuating elements – capacitance, piezo-mechanics, piezo-actuators as grippers, micro-grippers, micro motors, micro valves, micro-accelerometers, shape memory alloy based optical switch, thermally activated MEMS relay, micro-spring thermal actuator, data storage cantilever. **(10)**

4. Micro System Design: Design considerations, Design constraints and selection of materials, selection of manufacturing process, selection of signal transduction technique, Simulation based Micro-system design, need of simulation tool, use of finite element method, various simulation platforms. **(6)**

5. Micro Fluidic Systems (MFS): Devices, applications, considerations for MFS, fluid actuation methods, micro fluid dispensers- micro needle, micro fluid gates, micro pumps. **(4)**

6. Microsystems Packaging: Mechanical packaging of microelectronics, Micro system packaging – considerations and levels, interfaces in microsystem packaging, packaging technologies, three dimensional packaging, Assembly of microsystems. **(6)**

REFERENCE BOOKS:

1. Bharat Bhushan (Ed.), (2004), Handbook of Nanotechnology, Spinger-Verlag Berlin eidelberg New York, ISBN 3-540-01218-4
2. Hsu, Tai-Ran, (2003), MEMS & MICROSYSTEMS: Design & Manufacture, TMH, ISBN:0-07-048709-X
3. Mahalik, N. P., (2007), MEMS, TMH, ISBN: 0-07-063445-9
4. Mahalik, N.P. (Ed.) (2006), Micro manufacturing& Nanotechnology, Springer India Pvt. Ltd., ISBN: 978-81-8128-505-8 (Distributed by New Age International, New Delhi).

M.E. (CAD/CAM) Semester-I

4. COMPUTER AIDED MANUFACTURING

Teaching Scheme: **Examination Scheme:**
Lecturers: 3 Hrs/ Week Theory: 100 Marks

1. Introduction to CAM: CNC machine tools, Principle of operation of CNC, Construction features including structure, drives and CNC controllers, 2D and 3Dmachining on CNC. **(4)**

2. Metal cutting Optimization: Types of work materials, material designation, machining parameters selection and calculations for difference metals, effect of heat treatment prior to machining, types of chips, cutting fluids, economics of machining parameters , optimizing cutting parameters for minimum cost and maximum production.(Numerical approach). **(7)**

3. A) CNC Part Programming: Detailed Manual part programming on Lathe & Milling machines using G & M codes, FAPT programming (FANUC).

B) Computer aided CNC part programming: Generation of tool path, generation of G & M codes, Optimization of tool path (to reduce machining time), Design changes for manufacturing problems. (Features available on a typical CAM software)

(9)

4. CNC Tooling: Modern cutting tool materials and their applications, ISO nomenclature of tools and tool grades, Different types of tools and tool holders used on CNC Machines, parameters for selection of configuration of cutting tools, Modular toolings, Work holding devices used on CNC machines. **(6)**

5. A) Advanced CNC processes: EDM, Wire EDM, Abrasive water jet, LASER cutting, RPT, (Working principles, construction or set up of process, applications). **(5)**

B) Co-ordinate Measuring Machine: Working principle, Drives, Controls, Inspection routines, Applications of CMM software utilities. **(4)**

6. A) Geometric Dimensioning and Tolerancing: Geometrical dimensioning and tolerancing, Tolerance stacking, Types and remedies.

B) Design for manufacturing : Concept with case studies **(5)**

REFERENCE BOOKS:

1. Jon Stenerson and Kelly Curran "Computer Numerical Control", Prentice-Hall ofIndia Pvt. Ltd. New Delhi, 2008
2. Ibrahim Zeid "CAD/CAM – Theory and Practice" Mc Hill, International edition,1998
3. P. N. Rao "CAD/Cam principles and operations", Tata McGraw Hill4. Reference Manuals of FANUC, Siemens, Mazak, etc.
4. Thomas M. Crandell" CNC Machining and Programming, Industrial Press ISBn-0-8311-118-7
5. Bedworth, Wolfe and Henderson – "Computer aided design and manufacturing" - McGraw Hill
6. "Manufacturing Science" - A. Ghosh and Malik – Affiliated East West Press Pvt.Ltd.
7. Tilak Raj – "CNC Technology and Programming", Dhanpat Rai PublicationCompany.

M.E. (CAD/CAM) Semester-I

5. ELECTIVE-I ADVANCED DESIGN ENGINEERING

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs / Week	Theory Paper: 100 marks
Practical: 1 Hr. / week	Term Work: 25 marks

1. Engineering statistics and Optimization: Analysis of variance (ANOVA), factorial design and regression analysis, Reliability theory, design for reliability, Hazard analysis and fault tree analysis, Introduction to Optimization, multivariable search methods, linear & geometric programming, structural and shape optimization and simplex method.

(8)

2. Fatigue and Creep: Introduction, Fatigue strength, factors affecting fatigue behavior, Influence of super imposed static stress, Cumulative fatigue damage, fatigue under complex stresses, Fatigue strength after over stresses, True stress and true strength, mechanism of creep of material at high temperature, Exponential creep law, hyperbolic sine creep law, stress relaxation, bending etc.

(6)

3. Composite materials: Composite materials and structures, classical lamination theory, elastic stress analysis of composite material, Fatigue strength improvement techniques, stresses, stress concentration around cutouts in composite laminates, stability of composite laminate plates and shells, Hybrid materials, applications, smart materials, shape memory alloy. **(6)**

4. Design for Materials and Processes: Design for brittle fracture, Design for fatigue failure, Design for different machining process, assembly & safety etc.

(5)

5. Design of Mechanical components:

A) Gear Design: - Involute gears, tooth thickness, interference, undercutting, rack shift etc. Profile modification of spur, helical gears etc.

B) Spring Design:- Vibration and surging of helical springs, helical springs for maximum space

efficiency, analysis of Belleville springs, ring spring, volute spring & rubber springs. Design for spring suspension.

C) Design of Miscellaneous components:-Cam shaft with valve opening mechanism, piston, cylinder, connecting rod etc. **(6)**

6. Cams: Basic curves, cam size determination, calculating cam profiles, advance curves, polydyne cams, dynamics of high speed cam systems, surface materials, stresses and accuracy, ramps.

(6)

TERM WORK:

Minimum TEN Assignments based on the above topics.

REFERENCE BOOKS:

1. Mechanical Design Analysis – M.F. Spotts
2. Machine Design - Robert Norton
3. Practical Gear design - D.W. Dudley
4. Optimum design - R. C. Johnson
5. Mechanical Springs – A.M. Wahl.
6. An introduction to composite materials – D. Hull and T.W. Clyne
7. V Ramamurti, "Computer Aided Mechanical Design and Analysis", (Third Edition), Tata McGraw- Hill
8. G.E. Dieter, Mechanical Metallurgy, Tata McGraw-Hill, New Delhi.
9. G.E. Dieter, Engineering Design: A Materials and Processing Approach. McGraw-Hill
10. PSG Design Data Book.

M.E. (CAD/CAM) Semester-I

5. ELECTIVE-I ADVANCED TOOL DESIGN

Teaching Scheme:	**Examination Scheme:**
Lecturers: 3 Hrs/ Week	Theory: 100 Marks
Practical: 2 Hrs / week	Term Work: 25 marks

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 Nonferrous Tooling Materials- Carbides, Ceramics and Diamond, Nonmetallic tool materials, Designing with relation to heat treatment.

(8)

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

(9)

3. Design of Jigs: 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.

(6)

4. Design 0f Fixtures: Types of Fixtures, Vise Fixtures, Milling Fixtures, Boring Fixtures, Broaching Fixtures, Lathe Fixtures, Grinding Fixtures, Modular Fixtures, Cutting Force Calculations. **(4)**

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

(10)

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.

(8)

REFERENCES BOOKS:

1. Cyrll Donaldson, George H.LeCain, V.C. Goold, “Tool Design”, Tata McGraw Hill
2. Publishing Company Ltd., 2000.
3. E.G.Hoffman,” Jig and Fixture Design”, Thomson Asia Pvt Ltd, Singapore, 2004
4. PrakashHiralal Joshi, “Tooling data”, Wheeler Publishing, 2000
5. Venkataraman K., “Design of Jigs, Fixtures and Presstools”, TMH, 2005
6. Haslehurst M., “Manufacturing Technology”, The ELBS, 1978.

M.E. (CAD/CAM) Semester: – I

5. ELECTIVE I - DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS

Teaching Scheme:
Lecture: 3 hours per week
Practical: 2 hrs. per week

Examination Scheme:
Theory Paper: 100 marks
Term work: 25 marks

1. Oil Hydraulic Systems: Hydraulic power generators, Selection and specification of pumps, pump characteristics.

(02)

2. Hydraulic Actuators: Linear and Rotary Actuators - selection, specification and characteristics**.**

(02)

3. Control and Regulation Elements: Pressure, Direction and flow control valves, Relief valves, Non-return and safety valves, Actuation systems.

(10)

4. Hydraulic Circuits: Reciprocation, quick return, Sequencing, synchronizing circuits, Accumulator circuits, Industrial circuits, Press circuits ,Hydraulic milling machine, Grinding, planning, Copying, Forklift, Earth mover circuits, Design and selection of components, Safety and emergency mandrels.

(04)

5. Pneumatic Systems and Circuits: Pneumatic fundamentals, Control elements, Position and pressure sensing, Logic circuits, Switching circuits, Fringe conditions modules and these integration, Sequential circuits, Cascade methods, Mapping methods, Step counter method, Compound circuit design - combination circuit design.

(10)

6. Installation, Maintenance and Special Circuits: Pneumatic equipment's, Selection of components, Design calculations, Application, Fault finding, Hydro pneumatic circuits, Use of microprocessors for sequencing, PLC, Low cost automation, Robotic circuits.

(07)

TERM WORK:

1. Eight assignments with case studies on above topics.
2. Hydraulic or pneumatic system design for any industrial application.

REFERENCES BOOKS:

1. Antony Espossito, " Fluid power with Applications ", Prentice Hall, 1980.
2. Dudleyt, A.Pease and John J.Pippenger, " Basic Fluid Power ", Prentice Hall, 1987.
3. Andrew Parr, " Hydraulic and Pneumatics ", (HB), Jaico Publishing House, 1999.
4. Bolton. W. " Pneumatic and Hydraulic Systems ", Butterworth - Heineman, 1997.
5. Web References:1. www.pneumatics.com 2.www.fluidpower.com.tw

M.E. (CAD/CAM) Semester: – I

5. ELECTIVE I - 1. MECHATRONIC SYSTEM DESIGN

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hours per week	Theory Paper: 100 marks
Practical: 2 hrs. per week	Term work: 25 marks

1. A) Introduction: Introduction to mechatronic system, evolution, scope and components of mechatronic systems, mechatronics in product and measurement system, control system and modes of control, traditional design and mechatronic design.

B) Actuators, Sensors and Transducers: Hydraulic, pneumatic and electrical actuators and their system modeling, performance terminology, system modeling of sensors; displacement, position and proximity sensors, velocity and acceleration sensors, flow sensors, force sensors, temperature sensors, ultrasonic and fibre-optic sensors, selection of sensor, piezo-electric sensors.

(9)

2. Hardware Components: Number systems in Mechatronics, binary logic, Karnaugh map minimization, transducer signal conditioning process, principals of analogue and digital signal conditioning, protection, filtering, operational and instrumentation amplifiers and their gains, analogue to digital and digital to analogue conversion, multiplexers, pulse modulation.

(6)

3. Programmable Logic Controller: Review of logic gates, basic structure, features, input/output processing, programming, functional block diagram (FBD), ladder diagram, logic functions, latching, sequencing, jumps, internal relays, counters, shift registers, master and jump control, data handling, data movement, data comparison, arithmetic operations, code conversion, analog input and output, applications for automation, diagnostics and condition monitoring.

(6)

4. Microcontroller: Comparison between microprocessor and microcontroller, organization of microcontroller system, architecture of MCS 51 controller, pin diagram of 8051, addressing modes, programming of 8051, interfacing input and output devices, interfacing D/A converters and A/D converters, Various applications for automation and control purpose.

(6)

5. Real-Time Interfacing: Introduction, Elements of Data Acquisition and Control System, Overview of I/O Process, Installation of the I/O Card and Software, Installation of the application Software, Examples, Over framing. **(4)**

6. Advanced Applications in Mechatronics: Mechatronic control in automated manufacturing, Artificial Intelligence in mechatronics, Fuzzy Logic application in Mechatronics, Micro sensors in Mechatronics, and case studies of Mechatronic systems.

(5)

TERM WORK:

1. Minimum Three exercises on analog-digital trainer to study fundamentals of digital electronics
2. Minimum three programs on PLC for system automation involving of interfacing of sensors and actuators,
3. One exercise on interfacing of sensors and actuators with microcontroller
4. At least two exercises on a total Mechatronic System Design for applications like packaging,
   loading/unloading, pick and place etc.

REFERENCE BOOKS:

1. Mechatronics, 3/e --- W. Bolton (Pearson Education)
2. Mechatronics -Dan Necsulescu (Pearson Education)
3. The 8051 Microcontroller: Architecture, Programming and Applications, 2/e—Kenneth J.Ayala (Penram International)
4. Mechatronics: Principles, Concepts and Applications - N.P.Mahalik (TMH)
5. Introduction to Mechatronics & Measurement Systems – David G. Alciatore& Michael B.Histand (TMH)
6. Process Control & Instrumentation Technology –Critis D. Johnson (Pearson Education)
7. Mechatronics System Design – DevdasShetty, Richard A. Kolk (Thomson)
8. Computer Control of Manufacturing Systems - YoramKoren (McGraw Hill)
9. Automated Manufacturing Systems: Sensors, Actuators - S. Brain Morriss (McGraw Hill)
10. Industrial Automation – David W. Pessen (John Wiley & Sons)
11. 99 Examples of Pneumatic Applications – FESTO Controls Pvt. Ltd. Bangalore.
12. Modular Pick and Place Device– FESTO Controls Pvt. Ltd. Bangalore.
13. Rationalization with Handling Technology– FESTO Controls Pvt. Ltd. Bangalore.
14. Rationalization with Small Work piece Feeding- FESTO Controls Pvt. Ltd. Bangalore.
15. Sensors for Handling & Processing Pechnology- FESTO Controls Pvt. Ltd. Bangalore.
16. Sensors in Production Engg. - FESTO Controls Pvt. Ltd. Bangalore.
17. Handbook of Industrial Automation – Richard L. Shell & Ernest L. Hall (Marcel Decker Inc.)
18. Programmable Logic Controllers“Programming Methods and Applications” (with CD Rom) –Jack R. Hackworth & Fredrick D. Hackworth,Jr.(Pearson Education).

M.E. (CAD/CAM) Semester-I

6. CAD/CAM LABORATORY I

Teaching Scheme:
Practical: 2 Hrs/ Week

Examination Scheme:
Term Work: 50 marks
Oral: 25 marks

1. Introduction to Modeling software:

- 2D drawing and drafting using sketcher workbench – 2 drawings
- 3D modeling and drafting using 3D features – 5 models
- Assembling and drafting of 2 assemblies with interference checking.
- Surface modeling – 4 exercises

2. Computer aided manufacturing:

- CNC Lathe – 4 exercises
- CNC Machining Center – 4 exercises
- Generation of tool path, generation of NC code, Optimization of tool path(to reduce machining time) using any CAM software.

3. Co-ordinate Measuring Machine:

Case study: Inspection of a component using different probes, generation of report and interface (for example – Gears, Housings, Flywheels, Walls of machine structure, etc.)

Note- The term- work will be accessed on the basis of completion of above assignments and submission of report.
Refer Respective software manuals for the process

7. INSTRUMENTATION AND MEASUREMENT LABORATORY

Teaching Scheme:
Practical: 2 Hrs. per week.

Examination Scheme:
Term Work: 50 Marks
Oral: 25 Marks

The following experiments are to be performed in the laboratory

1. Measurements of mechanical parameters:

a) Displacement b) Force c) Torque

2. Measurement of hydraulic parameters:

a) Pressure b) vacuum c) Flow

3. Measurement of thermal parameters:

Temperature: Industrial thermo couples, Resistance thermometer, Radiation temperature measurement.

4. Measurement of vibration parameter:

a) Displacement -Vibrometer b) Velocity - Velocity pickup.

c) Acceleration- Accelerometer d) Frequency –Vibration Analyzer

5. Measurement of Sound parameters (Noise Meter):

a) Sound intensity level b) Sound Power level c) Sound Pressure level

6. Signal & system analysis.

Robot Programming, Sensory Devices

7. Condition monitoring & signature analysis applications.

Vibration signature analysis of different existing machines such as Lathe, Grinder, Blower etc.

8. Data acquisition & conversion.

Elements of a data acquisition system, characteristics of an analog-to-digital converter,

9. Microprocessor & computer application in measurements.

Microprocessor Architecture, Case study on CMM Application

REFERENCE BOOKS:

1. B. C. Nakra& K. K. Choudhary, “Instrumentation, Measurement & Analysis” TataMcGraw Hill Publications Pvt. Ltd., New Delhi.
2. Rangan& Sharma, “Instrument Devices & Systems”,Tata McGraw Hill Publications Pvt. Ltd. New Delhi.
3. Earnest O Doeblin, “Measurement Systems : Applications & Design”, McGraw Hill International.
4. 4.Walt Boyes “ Instrumentation Reference Book, 4th Edition , Butterworth-Heinemann ,Jordan Hill, UK
5. 5.Jhon A Bosh “ Coordinate measuring machines” Marcel Dekker INC, USA
6. 6.Fu K.S., Gonzalez R.C.., and Lee C.S.G., " Robotics control, sensing, vision, and intelligence McGraw-Hill Book Co., 1987.

8. SEMINAR – I

Teaching Scheme: **Examination Scheme:**
Tutorial: 2 HrS. per week. Term Work: 25 Marks

1. Seminar - I should be based on the literature survey on any topic relevant to CAD/CAM. It shall be leading to selection of a suitable topic of dissertation.
2. Each student has to prepare a write-up of about 25 pages. The report typed on A4 sized sheets and bound in the necessary format should be submitted after approval by the guide.

M.E. (CAD/CAM) Semester-II

1. PROODUCT LIFE CYCLE MANAGEMENT

Teaching Scheme:
Lectures: 3 Hrs/ Week
Practical: 2 Hr/Week

Examination Scheme:
Theory Paper: 100 marks
Term Work: 25 marks

1. Introduction: Background, Overview, Need, Benefits, Concept of Product Life Cycle. Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement. **(5)**

2. Product Life Cycle Environment : Product Data and Product Workflow, Company's PLM vision, The PLM Strategy, Principles for PLM strategy, Preparing for the PLM strategy, Developing a PLM strategy, Strategy identification and selection, Change Management for PLM.

(4)

3. Product Development Process & Methodologies : Integrated Product development process - **Conceive** – Specification, Concept design, **Design** – Detailed design, Validation and analysis (simulation), Tool design, **Realize** - Plan manufacturing , Manufacture, Build/Assemble , Test (quality check) , **Service -** Sell and Deliver , Use , Maintain and Support, Dispose. Bottom-up design, Top-down design, Front loading design workflow, Design in context, Modular design. **Concurrent engineering** – work structuring and team deployment - Product and process systemization - problem, identification and solving methodologies. Product Reliability, Mortality Curve. Design for Manufacturing, Design for Assembly. Design for Six Sigma. **(7)**

4. Product Modelling: Product Modeling - Definition of concepts, Fundamental issues, Role of Process chains and product models, Types of product models, Model Standardization efforts-types of process chains, Industrial demands.

(5)

5. Types of Analysis Tools: Design for manufacturing - machining - casting and metal forming - optimum design - Design for assembly and disassembly - probabilistic design concepts - FMEA - QFD -Taguchi Method for design of experiments -Design for product life cycle. Estimation of manufacturing costs, reducing the component costs and assembly costs, Minimize system complexity.

(5)

6. A) Product Data Management (PDM) Technology: Product Data Management, An Introduction to Concepts, Benefits and Terminology, CIM Data. PDM functions, definition and architectures of PDM systems, product data interchange, portal integration, PDM acquisition and implementation.

(5)

B) Recent Advances: Intelligent Information Systems - Knowledge based product and process models - Applications of soft computing in product development process - Advanced database design for integrated manufacturing. **(4)**

TERM WORK:

It shall consist of hands on case assignments on PLM software. It shall also include the eight assignments based on the entire syllabus.

REFERENCES:

1. Grieves, Michael. *Product Lifecycle Management*, McGraw-Hill, 2006.
2. Product Life Cycle Management - by AnttiSaaksvuori, AnselmiImmonen, Springer, 1st Edition (Nov.5, 2003)
3. Stark, John. *Product Lifecycle Management: Paradigm for 21st Century Product Realisation*, Springer-Verlag, 2004.
4. Product Design & Process Engineering, McGraw Hill – Kogalkusha Ltd., Tokyo,1974.
5. Product Design & Development – by Kari Ulrich and Steven D. Eppinger, McGraw Hill International Edns, 1999.
6. Effective Product Design and Development – by Stephen Rosenthol, Business One Orwin, Homewood, 1992 ISBN 1-55623-603-4.
7. Burden, Rodger *PDM: Product Data Management*, Resource Pub, 2003.
8. Clement, Jerry; Coldrick, Andy; & Sari, John. *Manufacturing Data Structures*, John Wiley & Sons, 1992.
9. Clements, Richard Barrett. Chapter 8 ("Design Control") and Chapter 9 ("Document Control") in *Quality Manager's Complete Guide to ISO 9000*, Prentice Hall, 1993.
10. Crnkovic, Ivica; Asklund, Ulf; &Dahlqvist, AnnitaPersson. *Implementing and Integrating Product Data Management and Software Configuration Management*, Artech House Publishers, 2003.
11. Garwood, Dave. *Bills of Materials for a Lean Enterprise*, Dogwood Publishing Co.,2004.
12. Fan, D. (Ed.), Virtual Reality for Industrial Applications, Springer.

M.E. (CAD/CAM) Semester-II

2. ADVANCED MECHANICS OF MATERIALS

Teaching Scheme:
Lectures: 3 Hrs. per week
Tutorial: 1 Hr. per week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

1. **Plane stress and plane strain**: Differential equations of equilibrium, Boundary conditions, Compatibility, Stress functions and Bi-harmonic equation.
(5)

2. **Two dimensional problems in Rectangular coordinates**: Applications to polynomials in rectangular coordinates, Saint-Venant's principle.
(5)

3. **Two dimensional problems in polar coordinates**: General equations in polar coordinates, Pure bending of curved bars, Strain components in polar coordinates, Rotating discs, stresses in a circular discs. **(6)**

4. **Shear center:** Shear stress distribution and shear center for thin walled open sections. Bending of Beams, energy methods, Introduction to elastic stability, plasticity
(4)

5. **Torsion:** Torsion of bars with elliptical square and rectangular cross section Membrane analogy, Hydro dynamical analogy, Torsion of hollow and thin tubes.
(6)

6. **A) Membrane stresses in shell and storage vessels,** Shells and vessels of uniform strength.

B) Contact stresses: Problem of determining contact stresses, Assumption Expressions for principal stresses, Examples.
(10)

TERM WORK:
Minimum TEN assignments based on above topics.

REFERENCE BOOKS:

1. S. Timoshenko and J.W. Goodier "Theory of Elasticity" MGH book co Ltd.
2. J.P. Den Hartog, "Advanced strength of materials" MGH book co Ltd.
3. F.B. Seety& Smith "Advanced mechanics of materials" John Wiley & Sons.
4. Irving H. Shames & James M. Pitarresi, "Introduction to Solid Mechanics", 3rd ed, PHI, pub.
5. Boresi, A.P. and Sidebottom, O.M., "Advanced Mechanics of Materials", John Wiley, 1993.
6. Chakrabarty, "Theory of Plasticity", McGraw-Hill Book Company, New York 1990.
7. Popov, E.P., "Engineering Mechanics of Solids", 2nd Ed., Prentice Hall India, 1998.

8. Crandall, S.H., Dahl, N.C. and Lardner, T.J., "An Introduction to the Mechanics of Solids", 2nd Ed, McGraw-Hill, 1978.
9. Nash W., "Strength of Materials", Schaum's outline series, McGraw Hill.
10. Timoshenko.S. and Young D.H. – "Elements of strength materials Vol. I and Vol. II". T. Van
Nostrand Co-Inc Princeton-N.J. 1990.
11. "Statics and Mechanics of Materials: An Integrated Approach", Riley, Sturges and Morris. Wiley, 2nd Edition.
12. Sadhu Singh – Theory of Elasticity, Khanna Publisher.

M.E. (CAD/CAM) Semester-II

3. AUTOMATION AND ROBOTICS

Teaching Scheme:	**Examination Scheme:**
Lecturers: 3 Hrs/ Week	Theory: 100 Marks
Tutorial: 1Hrs/ Week	Term work: 25 Marks

1. Introduction: Automated manufacturing systems, fixed /programmable /flexible automation, Need of automation, Basic elements of automated systems- power, program and control. Advanced automation functions, Levels of automation, Industrial control systems in process and discrete manufacturing industries, Continuous and discrete control; Low cost automation, Economic and social aspects of automation.

(07)

2. A) Assembly Automation: Types and configurations, Parts delivery at workstations-Various vibratory and non-vibratory devices for feeding and orientation, Product design for automated assembly.

B) Transfer Lines: Fundamentals, Configurations, Transfer mechanisms, storage buffers, control, applications; Analysis of transfer lines without storage buffers and with storage buffers.

(06)

3. Fundamentals of Industrial Robots and Robotic Control Systems: Specifications and Characteristics, Criteria for selection of robots, Drives, Robot Motions, Actuators, Power transmission systems, Robot controllers, Dynamic properties of robots-stability, control resolution, spatial resolution, accuracy, repeatability, compliance, work cell control, Interlocks.

(05)

4. Robotic End Effectors and Sensors: Transducers and sensors- sensors in robotics and their classification, Touch (Tactile) sensors, proximity and range sensors, force and torque sensors, End Effectors- Types, grippers, Various process tools as end effectors; Robot-end effector interface, Active and passive compliance, Gripper selection and design including numerical problems.

(05)

5. Robot Programming and Applications: Lead through method, Robot program as a path in space, Methods of defining positions in space, Motion interpolation, branching; Textual

robot programming languages-VAL II. Applications of robots for material transfer, machine loading unloading and processing applications**.**

(06)

6. Introduction to Mobile Robots: Introduction, Locomotion mechanisms, key issues for locomotion, classification of mobile robots: legged, wheeled and aerial mobile robots including areas of applications.

(04)

TERM WORK:

1) Minimum eight assignment based on above topics
2) Two robot programming exercises using VAL II based on topic eight

REFERENCE BOOKS:

1. Groover, M.P., (2004), "Automation, Production Systems and Computer Integrated Manufacturing", 2/e, (Pearson Edu.) ISBN: 81-7808-511-9
2. Groover, M.P.; Weiss, M.; Nagel, R.N. and Odrey, N.G. "Industrial Robotics, Technology, Programming & Applications", (McGraw Hill Intl. Ed.) ISBN:0-07-024989-X
3. Fu, K.S.; Gonzalez, R.C. & Lee, C.S.G. "Robotics-Control, Sensing, Vision and Intelligence", (McGraw Hill Intl. Ed.) ISBN:0-07-100421-1
4. Keramas, James G. (1998), " Robot Technology Fundamentals",(Thomson Learning-Delmar) ISBN: 981-240-621-2
5. Noff, Shimon Y. "Handbook of Robotics", (John Wiley & Sons)
6. Niku, Saeed B. (2002), "Introduction to Robotics, Analysis, Systems & Applications", (Prentice Hall of India)
7. Koren, Yoram,"Robotics for Engineers", (McGraw Hill)
8. Schilling, Robert J.(2004), "Fundamentals of Robotics, Analysis & Control", (PrenticeHall of India), ISBN: 81-203-1047-0
9. J J Craig Pierson Education, "Introduction to Robotics Mechanics and Control" 3rd Ed.
10. "Applied Robotics Volume I & II ", by Edwin Wise Cengage Learning
11. Roland Siegwart, Illah R. Nourbakgsh and Devide Scaramuzza, "Introduction to Autonomous Mobile Robots", 2nd Edition, 2011, ISBN-978-81-203-4322-1, PHI Publication.

M.E. (CAD/CAM) Semester-II

4. DESIGN OPTIMIZATION TECHNIQUES

Teaching Scheme:
Lecturers: 3 Hrs/ Week

Examination Scheme:
Theory: 100 Marks

1. Unconstrained Optimization Techniques

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

(10)

2. Constrained Optimization Techniques

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

(10)

3. Advanced Optimization Techniques

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

(9)

4. Static Applications

Structural applications – Design of simple truss members - Design applications – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members – Design of springs. **(6)**

5 Dynamic Applications

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

(5)

REFERENCES BOOKS:

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

M.E. (CAD/CAM) Semester-II

5. ELECTIVE-II NANO TECHNOLOGY

Teaching Scheme:
Lecturers: 3 Hrs/ Week
Tutorial: 1 Hrs/ Week

Examination Scheme:
Theory: 100 Marks
Term work: 25 Marks

1. Introduction to Nanotechnology: What is Nanotechnology, Nano scale, consequences of the Nano scale for technology and society, Beyond Moore's Law **(06)**

2. Technologies for the Nano scale: Top-down versus bottom –up assembly, Visualization, manipulation and characterization at the Nano scale, proximal probe technologies, Self-assembly, Biomimetic systems, Assemblers. **(08)**

3. Nano scale Manufacturing: Processing of metals, alloys, polymers, and ceramics. **(04)**

4. Lithography and Nanofabrication: patterning of thin films, electron beam lithography. **(04)**

5. Microstructure and Properties: Properties slightly dependent on temperature and grain size; properties strongly dependent on temperature and grain size; strengthening mechanisms; enhancement of available plasticity; grain size evolution and grain size control; Hall-Petch relation, microstructure – dislocation interactions at low and high temperatures; effects of diffusion on strength and flow of materials; methods of enhancing or retarding diffusion; grain boundary sliding and grain boundary migration; current limitations on approaches based on dislocation theory; possibilities for predictive design. **(08)**

6. Applications: Applications in Energy, Tribology, Informatics, nanotechnology in pharmaceutical applications, prosthetic and medical implants etc… **(07)**

TUTORIALS:

It shall consist of six exercises based on the syllabus.

REFERENCE BOOKS:

1. David ferry, transports in nanostructures, Cambridge University Press, 2000.
2. Engine of Creation, K E Drexler, Oxford Paperbackes, New York (1996).
3. K. A. Padmanabhan, "Mechanical Properties of Nanostructured Materials", Materials Science and Engineering, A 304-306 (2001) 200-205.
4. Y.Imry, Introduction to Mesoscopic Systems, Cambridge University Press, 1997
5. S.Datta, Electron Transport in mesoscope Systems, Cambridge University Press, 1995
6. H.Grabert and M. Devoret, Single Charge Tunneling, Plenum Press, 1992.

7. Beenaker and Van Houten, Quantum Transportun Semiconductor Nanostructures, insolid state physics v. 44, eds. Ehernreich and Turnball, Academic Press, 1991.
8. P. Rai- Choudhury, Handbook of Microlithography, Micromachining &Micro fabrication, SPIE, 1997.
9. Nanosystems: Molecular Machinery, Manufacturing & Computation, K E Drexler,(Wiley),1992, ISBN 0471575186
10. Our Molecular Furure: How Nanotechnology, Robotics, Genetics and Artificial Intelligence will transform the World, Prometheus (2002) ISBN 1573929921
11. Web Resources: www.nanotechweb.org, www.nano.gov, www.nanotec.org.uk
12. Principles of Nano Technology by Phani Kumar SCITECH

M.E. (CAD/CAM) Semester: – II

5. ELECTIVE-II INDUSTRIAL PRODUCT DESIGN

Teaching Scheme: **Examination Scheme:**
Lecture: 3 Hrs/week Theory: 100 Marks
Practical: 2 Hrs/week Term Work: 25 Marks

1. A) Introduction: challenges of product development; successful product, development quality aspect of product design; market research; survey.
(2)

B) Identify customer needs and Product Planning Processes. Product specifications: Process of setting specifications. concept generation, selection, testing
(4)

C) Product Architecture: Implication of architecture, establishing the architecture, related system level design issue. Industrial design: Overview
(4)

2. Design for manufacturing and assembly: tolerancing, design of gauges; design for environment; robust design, prototyping; engineering materials, concurrent engineering, product costing, value engineering, aesthetic concepts; visual effects of form and colour.
(6)

3. A) Product data management
(2)

B) Innovation and Creativity in Product Design: Case Studies.
(2)

4. A) Ergonomics and Industrial Safety (EIS):
Introduction, General approach to the man-machine relationship-workstation design working position and posture, An approach to industrial design, elements of design structure for industrial design in engineering applications in manufacturing systems.
(3)

B) Control and Displays: configurations and sizes of various controls and displays; design of controls in automobiles, machine tools etc., design of instruments and controls.
(2)

C) Ergonomics and Manufacturing: ergonomics and product design; ergonomics in automated Systems; anthropomorphic data and its applications in ergonomic design; limitations of anthropomorphic data, use of computerized database.
(4)

5. A) Safety & Occupational Health and Environment: application of ergonomics in industry for safety, health and environment control.
(2)

B) Prevention and specific safety measures for manufacturing and processing industry: safety in the use of machines, precaution for certain chemical types of industry like foundry, process industry, and chemical industry.
(3)

6. Environmental Safety and ISO 14000 Systems, Occupational Health**,** Health and Safety consideration; Personal protective Equipment.
(6)

TERM WORK:

Eight assignments based on above topics, case studies, using suitable modeling software.

REFERENCES:

1. Product Design and Development: Karl T. Ulrich, Steven G. Eppinger; Irwin McGraw Hill
2. Product design and Manufacture: A.C. Chitale and R.C. Gupta; PHI
3. New Product Development: Tim Jones, Butterworth, Heinemann, Oxford, 1997.
4. Product Design for Manufacture and Assembly: Geoffrey Boothroyd, Peter Dewhurst and
5. Winston Knight.
6. Product Design: Otto and Wood; Pearson education.
7. Industrial Design for Engineers: Mayall W.H, London, Hiffee books Ltd, 1988
8. Applied Ergonomics, Hand Book: Brian Shekel (Edited) Butterworth Scientific, London 1988.
9. Introduction to ergonomics – R.C. Bridger, McGraw Hill Pub.
10. Human Factor Engineering – Sanders & McCormick, McGraw Hill Publications.
11. Product Design – Kevin Otto, Kristin Wood Pierson Education

M.E. (CAD/CAM) Semester-II

5 ELLECTIVE-II COMPUTATIONAL FLUID DYNAMICS

Teaching Scheme:
Lecturers: 3 Hrs/ Week
Practicals: 2 Hrs/ Week

Examination Scheme:
Theory: 100 Marks
Term work: 25 Marks

1 Basic Concept:
Thermodynamics laws and relation, Energy equation, Continuity equation, Momentum equation, Mach number, Mach angle, various regions of flow.
(05)

2 A) One Dimensional Isentropic Flow:
Adiabatic flow and reference speed, Relation between M and M, Fllegnerl's formula, Impulse function, Gas tables and charts, Performance of convergent- divergent nozzle.
(05)

B) Normal Shocks:
Fanno process, Rayleigh process, Formation of shock wave, Prandtimeyer relation,pressure and temperature ratios across the shock, Stagnation pressure loss and increase in entropy, Supersonic diffusers.
(05)

3. Oblique Shocks:
Introduction, Governing equations, Prandtl relation, oblique shock relation, Mach angleand Mach waves, The shock polar.
(05)

4. Flow with Friction:
Governing equation, Fanno equation, Change in entropy, isothermal flow
(05)

5. A) Flow with Heat Transfer:
Governing equation, Rayliegh equation, Maximum enthalpy point, Maximum entropypoint, Valuation of fluid properties, Maximum heat
(05)

B) Equations of Motion:
Equation of motion in Cartesian co-ordinates, continuity equation, moment equation,Vorticity components, radial and tangential accelerations, Velocity potential, Stream function and its equation.
(05)

6. Measurement Techniques:
Wind tunnel, Suction tunnel, Supersonic tunnel, Shock tube, Flow visualization, Smoke techniques, Liquid film method, Measurement of Velocity, Measurement of Flow
(05)

TERM WORK:

Exercises (minimum six) using commercially available CFD Software in following areas like -

1. Heat transfer 2. Turbo machinery
3. Aerodynamics 4. Industrial processes involving fluid flow

REFERENCE BOOKS:

1. Computational Fluid Dynamics – The Basics with Applications, John D. Anderson, Jr., McGraw Hill, International Editions,
2. Computational Fluid Dynamics - The Finite Volume Method, H. K. Versteeg and W. Malalasekara, Longman Scientific & Technical
3. Computational Fluid Mechanics and Heat Transfer, John C. Tannehill, Dale A. Anderson and Richard H. Pletcher, Taylor & Francis, Reprint 2010.
4. Computational Methods for Fluid dynamics: Vol 1 and 2, C A J Fletcher, Springer Verlag, 1987
5. Numerical Heat Transfer & Fluid Flow, Suhas V. Patankar, Taylor & Francis.
6. Computational Fluid Dynamics Vol 1 and 2, K. A. Hoffmann and S. T. Chiang, Engineering Education System

M.E. (CAD/CAM) Semester: – II

5. ELECTIVE II: RELIABILITY ENGINEERING

Teaching Scheme:
Lectures: 3 Hours per week
Tutorial: 1 Hour per week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

1. A) Introduction: Brief history, Concepts, Terms and definitions, applications, the life cycle of a system, Concept of failure, typical engineering failures and their causes, Theory of probability and reliability, Rules of probability, Random variables, Discrete and continuous probability distributions.

B) Failure Data Analysis: Data collection and empirical methods, Estimation of performance measures for ungrouped compete data, Grouped complete data, Analysis of censored data, Fitting probability distributions graphically (Exponential and Weibull) and estimation of distribution parameters.

(8)

2. Reliability Measures: Reliability function–R(t), Cumulative distribution function (CDF), Probability density function (PDF), Hazard rate function, Mean time to failure (MTTF) and Mean time between failures (MTBF), Median time to failure, mode, Variance and standard deviation , Typical forms of hazard rate function, Bathtub curve and conditional reliability.
(5)

3. Basic Reliability Models: Constant failure rate (CFR) model, Failure modes, Renewal and Poisson process, Two parameter exponential distribution, Redundancy with CFR model, time-dependent failure models, Weibull, Rayleigh, Normal and Lognormal distributions, Burn-in screening for Weibull, Redundancy, Three parameter Weibull, Calculation of reliability parameters for above distributions.

(5)

4. Reliability Evaluation of Systems: Reliability block diagram, Series configuration, Parallel configuration, Mixed configurations, redundant systems, High level versus low level redundancy, k-out-of-n redundancy, Complex configurations, network reduction and decomposition methods, Cut and tie set approach for reliability evaluation.
(5)

5. A) Maintainability and Availability: Concept of maintainability, Measures of maintainability, Mean time to repair (MTTR), Analysis of downtime, Repair time distributions, Stochastic point processes, Maintenance concept and procedures, Availability concepts and definitions, Important availability measures.

B) Design for Reliability and Maintainability: Reliability design process and design methods, Reliability allocation, Failure modes, effects and criticality analysis (FMECA), Fault tree and success tree methods, Symbols used, Maintainability design process, Quantifiable measures of maintainability, Repair versus replacement.

(10)

6. Reliability Testing: Product testing, Reliability life testing, Burn-in testing, Acceptance testing, Accelerated life testing and reliability growth testing.
(5)

TERM WORK:

Minimum Eight assignments based on above topics with an emphasis on examples of reliability of components and systems.

TEXT BOOKS:

1. Charles E. Ebling, 2004, An Introduction to Reliability and Maintainability Engineering, Tata McGraw Hill Education Private Limited, New Delhi.
2. L. S. Srinath, 1991, "Reliability Engineering", East West Press, New Delhi.
3. Alessandro Birolini, 2010, "Reliability Engineering: Theory and Practice", Springer.
4. Roy Billiton and Ronald Norman Allan, 1992, "Reliability evaluation of engineering systems: concepts and techniques", Springer.
5. Patrick D.T. O'Conner, David Newton, Richard Bromley, 2002, "Practical Reliability Engineering" John Wiley and Sons.
6. Joel A. Nachlas, 2005, "Reliability Engineering: Probabilistic Models and Maintenance Methods" Taylor and Francis.

REFERENCE BOOKS:

1. Guangbin Yang, 2007, "Life cycle reliability engineering", John Wiley and Sons.
2. W. R. Blischke, D.N.P. Murthy, 2003, "Case studies in Reliability and Maintenance", John Wiley and Sons.
3. Andrew Kennedy, Skilling Jardine, Albert H. C. Tsang, 2006, "Maintenance, Replacement and Reliability: Theory and Applications", CRC/Taylor and Francis.
4. B. S. Dhillon, Chanan Singh, 1981, Engineering Reliability – New Techniques and Applications", John Wiley and Sons.
5. B. S. Dhillon, 1999, "Engineering Maintainability", Prentice Hall of India.

M.E. (CAD/CAM) Semester-II

6. CAD /CAM LABORATORY II

Teaching Scheme:
Practical: 2 Hrs/ Week

Examination Scheme:
Term Work: 25 marks
Oral: 25 marks

Minimum eight exercises are to be completed on following topics using suitable software packages.

1. Transient Thermal Analysis.
2. Dynamic Analysis
3. Non-Linear Analysis
4. Design Optimization through FEA (Two Exercises)

The Term work shall be assessed on the basis of completion of above exercises and submission of report.

M.E. (CAD/CAM) Semester-II

7. SIMULATION AND ANALYSIS LAB

Teaching Scheme:
Practical: 2 Hrs/ Week

Examination Scheme:
Term work: 25 Marks

Minimum eight exercises are to be completed on following topics using suitable software.

1) Simulation and Machining using CNC / DNC Machine Tools.(Minimum two)
2) Use of FEM Packages - Relational Data Base – Networking.
3) Practice on Computer Aided Measuring Instruments.
4) Software Development for Manufacturing.
5) CNC Controllers for manufacturing.
6) Use of advanced CNC Machining Packages.

M.E. (CAD/CAM) Semester-II

8. SEMINAR II

Teaching Scheme:
Practical: 1 Hour/ Week

Examination Scheme:
Term Work: 25 marks

1. Seminar - II should be based on the literature survey on any topic relevant to CAD/CAM. It may be leading to selection of a suitable topic of dissertation. The report shall contain some contribution by the candidate in the form of experimental results, deductions, compilation and inferences etc.
2. Each student has to prepare a write-up of about 25 pages. The report typed on A4 sized sheets and bound in the necessary format should be submitted after approved by the guide.

M.E. (CAD/CAM) Semester-II

9. Comprehensive Viva

Examination scheme:
Oral: 50 Marks

The students have to prepare on all subjects, they have studied In I and II semesters. The viva will be conducted by the External/Internal Examiner jointly and their appointments will be made by university. The in-depth knowledge, preparation and subjects understanding will be assessed by the Examiners.

M.E. (CAD/CAM) Semester-III

1. MINI PROJECT

Teaching Scheme: **Examination Scheme**:

Term work: 50 marks

Oral: 50 Marks

A Mini Project based on the subjects studied during Semester-I and Semester-II, shall be undertaken and completed by the candidate during vacation after Semester-II. The report of this project shall be submitted in the prescribed format at the beginning of Semester III. It will be approved by the guide. It will be assessed for term work during Semester III, by the evaluation committee formed by department.

M.E. (CAD/CAM) Semester – III

2. DISSERTATION PHASE-I

Teaching Scheme: **Examination Scheme**:

Contact hours-4hrs per week

Term work: 50 Marks

Oral: 50 Marks

The term work under this submitted by the student shall include.

1) Work diary maintained by the student and countersigned by his guide.

2) The content of work diary shall reflect the efforts taken by candidates for
   a) Survey for suitable project work.
   b) Establishing suitable problem definition.
   c) Brief report on web sites, journals and various papers referred for project work.
   d) The brief report of feasibility studies carried to come to final conclusion.
   e) Rough sketches if required.
   f) Design calculations etc. carried by the student.

3) The student has to make a presentation in front of panel of experts along with the guide.

M.E. (CAD/CAM) Semester – IV

1. DISSERTATION PHASE-II

Teaching Scheme:
Contact hours: 4hrs per week

Examination Scheme:
Term work: 100 Marks
Oral: 100 Marks

The dissertation submitted by the student on topic already approved by university authorities on the basis of synopsis submitted by the candidate, shall be according to the following guide lines.

Format of dissertation report:

The dissertation work report shall be typed on A4 size bond paper. The total No. of minimum pages shall not be less than 60. Figures, graphs, annexure etc. should be added as per the requirement.

The report should be written in the format as given below-

1. Title sheet
2. Certificate
3. Acknowledgement
4. List of figures, Photographs/Graphs/Tables
5. Abbreviations.
6. Abstract
7. Contents.
8. Text with usual scheme of chapters.
9. Discussion of the results and conclusions
10. Bibliography (the source of illustrative matter be acknowledged clearly at appropriate place as per IEEE/ASME/Elsevier Format)