FIRST YEAR MASTER OF ENGINEERING AND TECHNOLOGY (M.Tech) – CBCS PATTERN (PRODUCTION -CAD/CAM/CAE)

2018-19

SEMESTER - I

Sr. No	Course (Subject Title)	TEACHING SCHEME									EXAMINATION SCHEME											
		THEORY			TUTORIAL			PRACTICAL			THEORY					PRACTICAL			TERM WORK		
		Credits	No. of Lecture	Hours	Credits	No. of Lecture	Hours	Credits	No. of Lecture	Hours	Hours	Mode	Marks	Total Marks	Min	Hours	Max	Min	Hours	Max	Min
1	PCCPRODPG101	3	3	3	1	1	1	-	-	-		CIE	30	100	40	As per BOS Guidelines	-	-	2	25	10
												ESE	70								
2	PCCPRODPG102	3	3	3	-	-	-	1	2	2		CIE	30	100	40		-	-	2	25	20
												ESE	70								
3	PCCPRODPG103	3	3	3	1	1	1	-	-	-		CIE	30	100	40		-	-	2	25	10
												ESE	70								
4	PCCPRODPG104	3	3	3	1	1	1	-	-	-		CIE	30	100	40		-	-	2	25	10
												ESE	70								
5	PCEPRODPG105	3	3	3	-	-	-	1	2	2		CIE	30	100	40		25	10	2	25	10
												ESE	70								
6	PCCPRODPG106		-	-	-	-	-	2	2	2		-	-	-	-		25	10	2	25	10
7	PCCPRODPG107		-	-	-	-	-	2	2	2		-	-	-	-				-	25	10
8	PCCPRODPG108		-	-	-	-	-	1	2	2		-	-	-	-		-	-	-	25	10
	TOTAL	**15**	**15**	**15**	**3**	**3**	**3**	**7**	**10**	**10**				**500**			**50**			**200**	

SEMESTER –II

1	PCCPRODPG201	3	3	3	-	-	-	1	2	2		CIE	30	100	40	BOS Guideli	-	-	2	25	10
												ESE	70								

2	PCCPRODPG202	3	3	3		1	1	1		-	-	-			CIE	30	100	40		-	-	2	25	10
															ESE	70							
3	PCCPRODPG203	3	3	3		-	-	-		1	2	2			CIE	30	100	40		-	-	2	25	10
															ESE	70							
4	PCCPRODPG204	3	3	3		1	1	1		-	-	-			CIE	30	100	40		-	-	2	25	10
															ESE	70							
5	PCCPRODPG205	3	3	3		-	-	-		1	2	2			CIE	30	100	40		-	-	2	25	10
															ESE	70							
6	PCCPRODPG206	-	-	-		-	-	-		2	2	2			-	-	-	-		25	10	2	25	10
7	PCCPRODPG207	-	-	-		-	-	-		1	2	2			-	-	-	-		-	-	2	25	10
8	PCCPRODPG208	-	-	-		-	-	-		1	2	2			-	-	-	-		-	-	2	25	10
9	PCCPRODPG209	-	-	-		-	-	-		1	---	---			-	-	-	-	-	25	10	-	-	
	TOTAL	**15**	**15**	**15**		2	2	2		**8**	**12**	**12**					**500**			**50**			**200**	
	TOTAL	**30**	**30**	**30**		**5**	**5**	**5**		**15**	**22**	**22**					**1000**			**100**			**400**	

CIE- Continuous Internal Evaluation
ESE – End Semester Examination

• Candidate contact hours per week : 30 Hours (Minimum)	• Total Marks for M.E. Sem I& II : **1500**
• Theory/Tutorial Duration : 60 Minutes and Practical Duration : 120 Minutes	• Total Credits for M.E. Sem I & II: **50**
• In theory examination there will be a passing based on separate head of passing for examination of CIE and ESE.	
• There shall be separate passing for theory and practical (term work) courses.	

Note :

1.Professional Core Course-ProductionEngineering (PCC-PROD) are compulsory.

ELECTIVE-I

1. **Advanced Design Engineering**
2. **Advanced Tool Design**
3. **Theory of Plasticity and Elasticity**
4. **Mechatronic System Design**
5. **Design of Hydraulic and Pneumatic System**

ELECTIVE-II

1. **Nano Technology**
2. **Quality and Reliability Engineering**
3. **Advanced Metal forming or CAD/CAM/CAE Practices in Metal forming**
4. **Computational Fluid Dynamics**
5. **Advanced Casting Technology**

SECOND YEAR MASTER OF ENGINEERING AND TECHNOLOGY (M.Tech) – CBCS PATTERN (PRODUCTION -CAD/CAM/CAE)

SEMESTER –III																						
1.	PCCPRODPG301	--	--	--		-	-	-	2	--	--		--	--	--	--	--	BOS Guideli	-	-	2	25	10
2.	PCCPRODPG302	--	--	--		--	--	--	2	2	2		--	--	--	--	--		25	10	2	25	10
3.	PCCPRODPG303	--	--	--		--	--	--	1	--	--		--	--	--	--	--					25	10
	TOTAL	**--**	**--**	**--**		**--**	**--**	**--**	**5**	**2**	**2**								**25**	**10**		**75**	**30**

SEMESTER –IV																						
1.	PCCPRODPG401	--	--	--		--	--	--	5	5	5		--	--	--	--	--		100	40	2	100	40
	TOTAL	**--**	**--**	**--**		**--**	**--**	**--**	**5**	**5**	**5**								**100**	**40**		**100**	**40**

• Candidate contact hours per week : 30 Hours (Minimum)	• Total Marks for M.E. Sem I & II : **300**
• Theory/Tutorial Duration : 60 Minutes and Practical Duration : 120 Minutes	• Total Credits for M.E. Sem I & II : **10**
• In theory examination there will be a passing based on separate head of passing for examination of CIE and ESE.	
• There shall be separate passing for theory and practical (term work) courses.	

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.

COURSE CODE AND DEFINITION

Semester I

Sr. No	Code No.	Subject	Credits
1.	PCCPRODPG101	Design of Experiments & Research Methodology	04
2.	PCCPRODPG102	Advanced Finite Element Analysis	04
3.	PCCPRODPG103	Micro Electro-Mechanical Systems	04
4.	PCCPRODPG104	Computer Aided Manufacturing	04
5.	PCEPRODPG105	Elective I	04
6.	PCCPRODPG106	CAD/CAM Laboratory I	02
7.	PCCPRODPG107	Instrumentation and Control Lab	02
8.	PCCPRODPG108	Seminar-I	01

Semester II

Sr. No	Code No.	Subject	Credits
1.	PCCPRODPG201	Product Life Cycle Management	4
2.	PCCPRODPG202	AdvancedMechanics ofMaterials	4
3.	PCCPRODPG203	Automation &Robotics	4
4.	PCCPRODPG204	Design Optimization Techniques	4
5.	PCCPRODPG205	Elective II	4
6.	PCCPRODPG206	CAD/CAM Lab II	2
7.	PCCPRODPG207	Simulation and Analysis Lab	1
8.	PCCPRODPG208	**Seminar II**	1
9.	PCCPRODPG209	**Comprehensive**	1

		Viva	

Semester III

Sr. No	Code No.	Subject	Credits
1.	PCCPRODPG301	Mini Project	2
2.	PCCPRODPG302	Dissertation Phase-I	2
3.	PCCPRODPG303	Industrial Training	1

Semester IV

Sr. No	Code No.	Subject	Credits
1.	PCCPRODPG401	Dissertation Phase-II	5

M.TECH (CAD/CAM/CAE) Semester:– I

1. COMPUTER AIDED DRAFTING

Teaching Scheme: Examination Scheme: Practical: 2 hrs/week

Term Work: 25 Marks Credit :03

UNIT 1.Introduction: Definitions, Historical Development. Geometric Modeling, Nameable and Unnamable shapes, Explicit and Implicit Equations, Intrinsic Equations, Parametric Equations, Coordinate Systems. **Design Of Curves:** Algebraic and Geometric Forms, Parametric space of a curve, Blending functions, Reparametrization, Truncating, Extending and subdividing, Space curve, Four point form, Straight lines, Spline Curves, Bezier Curves, B-spline Curves, Rational Polynomials, introduction to NURBS Design Of **Surfaces:** Algebraic and Geometric form, Tangent and Twist Vectors, Normal, Parametric space of a surface, Blending Functions, Reparametrization of a surface patch, subdividing, Sixteen Point form, Four Curve Form, Plane surface, Cylindrical Surface, Ruled surface, Surface of Revolution. Bezier Surface, B-Spline Surface.

UNIT 2.Solid Modeling Fundamentals: Topology of Closed Paths, Piecewise flat surfaces, topology of closed curved surfaces, Generalized Concept of boundary, Set theory, Boolean operators, Set-membership Classification, Euler operators, Formal Modeling Criteria.

UNIT3.Solid Model Construction: Graph Based methods, Boolean models, Instances and Parameterized Shapes, Cell Decomposition and spatial-Occupancy Enumeration, Sweep Representation, Constructive Solid Geometry, Boundary Representation

UNIT4.Transformations: Translation, Rotation, Scaling Symmetry and Reflection, Homogeneous Transformations. Orthographic Projections, Axonometric Projections, Oblique Projections, Perspective Transformation.

UNIT5.Introduction to Assembly-modeling, Analytical Properties, Relational Properties and intersections, Data transfer formats.

UNIT6.Applications: Implementation of the algorithms on MATLAB, Construction of Solid and Surface Models on any of the high end solid modelers (IDEAS / ProE and ImagewareSurfacer).

Books: 1.

Geometric Modeling: Michael E. Mortension, John Wiley.

2. Mathematical Elements of Computer Graphics: Roger and Adams, McGraw Hill.

3. CAD CAM Theory and Practice: I. Zeid, McGraw Hill.

4. Computer Aided Engineering Design, Saxena and Sahay, Anamaya N. Delhi

M.TECH (CAD/CAM/CAE) Semester:– I
2. ADVANCED MACHINE DESIGN

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Credit: 03
Practical: 1 Hr/ Week/ Batch	Term Work: 25 marks

Objectives:

1. To revise the fundamentals of stress analysis and vibration analysis.
2. To lay a strong foundation for design analysis.

UNIT1.Analysis of Stress: State of stress at a point, stress components on an arbitrary plane, principalstresses, Mohr's circle, plane stress, differential equations of equilibrium, boundary conditions.

UNIT2. Analysis of Strain: State of strain at a point, dilation, plane strain, compatibility conditions.

UNIT3.Stress-Strain Relations: Generalizes Hooke's Law, relations between elastic constants,displacement equations of equilibrium.

UNIT4.Theories of Failure: Theory of dislocations, Maximum principal stress theory, maximumshear stress theory, maximum elastic strain theory, octahedral shearing stress theory, distortion energy theory, Mohr's theory, significance of theory of failure, use of factor of safety in design, selection of materials for engineering applications.

UNIT5. Energy Methods: Elastic strain energy, Maxwell-Betti-Rayleigh reciprocal theorem,Castigliano's theorems, strain energy due to axial force, shear force, torsion, bending moment, theory of virtual work.Axi-symmetric Problems: Thick-walled cylinders, shrink fits, rotating discs.

UNIT6. **Fatigue Considerations in Design** : Variable loads- basic concepts; Load and Stressvariations- different patterns; Cyclic stressing/straining- material response and the origin of fatigue failure; S-N curve - fatigue strength and endurance limit; Factors influencing fatigue, endurance strength modification factors; Fatigue stress concentration; Effect of mean stress-Goodman and Soderberg relations; Design approach to fatigue- design for infinite and finite life; Design of members under combined loading.

TERM WORK

Minimum six assignments based on the above topics including two exercises involving analysis and design modification for critical components using reverse engineering approach. (e.g. need to change material specifications of a connecting rod, etc.)

REFERENCE BOOKS

1. Advanced Solid Mechanics – L S Srinath, Tata McGraw-Hill
2. Theory of Elasticity (Third Edition) – S P Timoshenko, J N Goodier, McGraw-Hill
3. Computer Aided Mechanical Design and Analysis (Third Edition) – V Ramamurti, Tata McGraw-Hill
4. Elements of Vibration Analysis – L Meirovitch, McGraw-Hill
5. Design of Machine Elements – M.F. Spotts& T.E. Shoup, Pearson Education
6. Mechanical Engineering Design – Joseph E. Shigley&Chales R. Mischke, McGraw Hill
7. Engineering Design –George B. Dieter, McGraw Hill
8. Machine Design, An Integrated Approach – Robert L. Norton, Pearson Education
9. Mechanical Analysis & Design – Arhur H. Burr & John B. Chetham, Prentice Hall India
10. Fundamentals of Machine Component Design – Robert C. Juvinall & Kurt M. Marshel, John Wiley & Sons
11. Mechanical Vibrations (Fourth Edition) – S SRao, Pearson Education

12. Fundamentals of Mechanical Vibrations – S Graham Kelly, McGraw-Hill

13. Mechanical Vibrations – G.K. Groover, Nemchand& Brothers, Roorkee.

14. Fundamentals of Machine Component Design – R. C. Juvinall

M.TECH (CAD/CAM/CAE) Semester – I

3. Advanced Finite Element Analysis

Teaching Scheme:

Lectures: 3 Hrs/ Week

Examination Scheme:

Credit : 03

Pre-requisites:

- A basic understanding of vectors, matrices and partial differential equations for thermal and mechanical problems.

Course Objectives:

- To provide the mathematical foundations of the finite element formulation for engineering applications
- To expose students to some of the recent trends and research areas in finite element analysis.

UNIT1. Introduction to Finite Element Method: Basic Concept, Historical Background, ngineering applications, general Description, comparison with other methods. **(3)**

UNIT2. 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)**

UNIT3. Finite Element Techniques: Module boundary value problem, finite elementdecartelization, 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)

UNIT4.Applications to Solid and Structural Mechanics Problems: External and internalequilibrium 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. Applications to Heat Transfer Problems: Variational approach, Galerikn approach one dimensional and two dimensional steady state problems for conduction, convection and radiation, transient problems. **(10)**

UNIT 5.Applications to Fluid Mechanics Problems: Inviscid incompressible flow, potentialfunction and stream function formulation, incompressible viscous flow, stream function, velocity-pressure and stream function voricity formulation, solution of incompressible and compressible fluid film lubrication problems, Additional Applications: Steady state
and transient field problem. **(7)**

UNIT 6. Parameters Affecting Accuracy of the FEA results: How to validate and checkaccuracy 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.TECH (CAD/CAM/CAE) Semester:– I

ELECTIVE I - 1. MECHATRONIC SYSTEM DESIGN

Lecture: 3 hours per week

University Exam: **Credit : 03**

Practical: 2 hrs per week Term work: 25 marks

Course Objective

To study components of mechatronic systems and their integration for various applications.

UNIT1. Introduction: Introduction to mechatronic system, evolution, scope and components ofmechatronic systems, mechatronics in product and measurement system, control system and modes of control, traditional design and mechatronic design **(3)**

UNIT2. Actuators, Sensors and Transducers: Hydraulic, pneumatic and electrical actuators and theirsystem 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. **(6)**

UNIT3.Hardware Components: Number systems in Mechatronics, binary logic, Karnaugh mapminimization, 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)**

UNIT4. 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)

UNIT5.Microcontroller: Comparison between microprocessor and microcontroller, organization ofmicrocontroller 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)**

UNIT6. Real-Time Interfacing applications : 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.Advanced Applications in Mechatronics**:** Mechatronic control in automated manufacturing,Artificial Intelligence in mechatronics, Fuzzy Logic application in Mechatronics, Microsensors in Mechatronics, Case studies of Mechatronic systems. **(9)**

TERM WORK

1. Minimum two exercises on analog-digital trainer to study fundamentals of digital electronics.
2. Two experiments based on Timers and Counteron PLC Trainer kit.
3. One assignment on Microprocessor. andMicrocontroller.
4. Assignment on practical advanced application of mechatronics systems.

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 Workpiece 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.TECH (CAD/CAM/CAE) Semester:– I

Elective I - 2. DESIGN & DEVELOPMENT OF CAD/CAM/CAE ENGINEERING

Teaching Load: **Examination Scheme:**

Credit : 03

Lectures 3 Hrs/ week

Practical: 2 Hrs/ Week Term work: 25 marks

Course Objective:

To understand the methodologies for development of CAD/CAM/CAE Software and its customization.

UNIT 1. Introduction to Software Development**:** Customization, Application Programming Interface (API), macros, scripts. **(4)**

UNIT2.Tools for Customization: Object Oriented Programming (OOP), OLE interfaces in CAD/CAM software, Use of general programming interfaces like VB, VBS, VC++, JAVA, OpenGL programming and System dependent programming interfaces like, Visual LISP (AutoCAD), GRIP (Unigraphics), Pro-Programming (Pro-Engineer), CATIA, SOLIDWORKS etc. **(4)**

UNIT3. Computer-based System Engineering: System engineering process, Software product development life cycle, software processes, software development project management, software prototyping **(8)**

UNIT4. Rapid Development: Core issues in rapid development, rapid development languages, life cycle planning and customer oriented development **(4)**

UNIT5.Solid Modeling Algorithms: Euler operations, basic solid modeling algorithms Parametric Modeling: Computer Aided Process Planning, Parametric Modeling**(7)**

UNIT6. Automated Solid Modeling using Customization: Creating 2D, 3D and solid entities through API, Editing 2D, 3D and solid entities through API, Design and development of user interfaces- icons, menus, dialog boxes, integrating databases with CAD, creating bill of material or parts list, automated assembly modeling throughcustomization, automated drafting and dimensioning using customization, creating automated animations using API and animation software. **(8)**

Term Work:

Minimum six exercise based on the above syllabus.

Reference Books

1. Rapid Development,- Steve McConnel, Microsoft Press
2. Software Engineering – Ian Sommerville, Pearson Education

3. Computer Gtraphics – Foley, Van Dam, et al, Pearson Education
4. Open GL Programming Guide – Mason Woo et al,
5. Advanced AutoCAD – George Omura
6. Customizing AutoCAD – ShyamTickoo, Thomson Learning
7. CATIA - ShyamTickoo, Thomson Learning
8. Solid Modelling – MarttiMantilya, Computer Science Press
9. Solid Works API Using VB and C++ - Custom Programming Unlimited LLC
10. GRIP Programming Manuals for Unigraphics – Vol. I & II
11. User Function Programming Manuals for Unigraphics– Vol. I, II & III

User Manuals for CATIA

M.TECH (CAD/CAM/CAE) Semester:– I

Elective I - 3. THEORY OF ELEASTICITY AND PLASTICITY

Teaching Load:	**Examination Scheme**
Lectures 3 Hrs/ week	Credit : 03
Practical: 2 Hrs/ Week	Term work: 25 marks

Unit 1: Analysis of Stress 9 hrs
Basic concepts: Body force, Surface Force, Stresses, Components of Stresses, State of stress at a point, Stress components on an arbitrary plane, Principal stresses, Shear stresses, Stress transformation, Mohr's circle in 3D, Plane stress, Differential equations of equilibrium, Boundary conditions, Stress invariants, Octahedral stresses, Decomposition of a state of stress.

Unit 2:Analysis of Strain 5 hrs.
Deformation, Strain displacement relations, Strain components, State of strain at a point, Dilatation, Compatibility conditions, Plane strain

Unit 3:Stress- Strain relations 4 hrs
Generalized Hookes Law in terms of elastic constants, Relations between elastic constants, Displacement equations of equilibrium, Saint Venants principle

Unit 4(A):--Two dimensional problems in Cartesian co-ordinates 6hrs
Airy's stress function, Biharmonic equilibrium equations, Investigation for simple beam problems: (a) Bending of a cantilever beam with end load. (b) Simply supported beam with uniform load.

Unit 4(B): Analysis of axi-symmetric problems and Torsion 7 hrs.
Axi-symmetric problems:General equations in polar co-ordinates, Thick-walled cylinder subjected to external and internal pressure, Rotating disc as a 2D problem, Shrink fits
Torsion:
Torsion of prismatic (circular and elliptical cross-section) bars, Soap film

analogy, Membrane analogy

Unit 5 : Energy Methods 8 hrs
Concept of elastic strain energy, Strain energy due to axial force, shear force, torsion, bending moment, Principle of superposition, Maxwell-Betti-Rayleigh reciprocal theorem, Castigliano's theorems, Principle of virtual work.

Unit 6 :Plasticity 9 hrs
Basic concepts and yield criteria ; Plastic stress-strain relations, Prandtl- Rouss Saint Venant, Levy-Von Mises,Experimentalverification of the Prandtl- Rouss equation Upper and lower bound theorems and corollaries, Application to problems: Uniaxial tension and compression, Stages of plastic yielding, Elasto-plastic analysis of torsion and bending problems, torsion of a bar of oval section (Sokoloskey's method), problems of spherical and axial symmetry, slip lines and plastic flow, strain hardening.

TERM WORK:
1.Ten assignments on above topics
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References:

1. S. P. Timoshenko and J N Goodier,
"Theory of Elasticity", McGraw Hill Book Company.
2. L. S. Srinath,
"Advanced Mechanics of Solid"
, Tata McGraw Hill Book Company .
3. Richard G Budynas, "Advanced Strength and Applied Stress Analysis", McGraw Hill , New Delhi, Second Edition, 2011.
4. Engineering Plasticity - Theory and Application to Metal Forming Process -R.A.C..Slater, McMillan Press Ltd., 1977
5. Theory of Plasticity and Metal forming Process - Sadhu Singh, KhannaPublishers, Delhi, 1999.

1] Sadhusingh, "Theory of Elasticity", Khanna Publishers, New Delhi, Fourth Edition, 2012.2.
2] Wang C. T. , "Applied Elasticity", McGraw Hill, New Delhi, 1990.
3.L. D. Landau and E. M. Lifshitz, "Theory of Elasticity", Vikas Publishing House Private. Ltd, New Delhi.
4. T. G. Sitharam, "Applied Elasticity", Interline Publishing.

5. Phillips, Durelli and Tsao, "Analysis of Stress and Strain"McGraw Hill Book Company.
6. Introduction to the Theory of Plasticity for Engineers- Haffman and Sachs, LLC, 2012.
7. Theory of plasticity - J Chakrabarty, Butterworth, 2006.
8. Plasticity for Mechanical Engineers - Johnson and Mellor, Van Nostrand, 1966

M.TECH (CAD/CAM/CAE) Semester:– I

ELECTIVE I - 4. DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS

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

Examination Scheme:
Credit : 03
Term work: 25 marks

UNIT 1. Oil Hydraulic Systems: Hydraulic power generators, Selection and specification of pumps, pump characteristics.**(02)**

UNIT 2. Hydraulic Actuators: Linear and Rotary Actuators - selection, specification and characteristics**.(02)**

UNIT 3. Control and Regulation Elements: Pressure, Direction and flow control valves, Relief valves, Non-return and safety valves, Actuation systems.**(10)**

UNIT 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)**

UNIT 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)**

UNIT 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.TECH (CAD/CAM/CAE) Semester:– I

Elective II -1 . DESIGN OF EXPERIMENTS & RESEARCH METHODOLOGY

Teaching Scheme:

Lectures: 3 Hrs / Week

Examination Scheme:

Credit :03

Practical: 1 Hr. / week

Term Work: 25 marks

Course Objective:

To prepare the orientation of the student towards research and to understand the techniques in design of research and experimentation.

UNIT 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 ComparativeExperiments-**Basic statistical concepts, random variable, sample mean and variance,degrees of freedom, standard normal distribution, statistical hypothesis, Two sample *t*-test, *P*-value, Confidence Intervals, Paired comparison. **(6)**

UNIT 2.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.

Two factor Factorial Design**:** Basic definitions and principles, main effect andinteraction, response surface and contour plots, Blocking, General arrangement for a two-factor factorial design; Models- Effects, means and regression, **(8)**

UNIT 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 **(5)**

UNIT 4.Research: Definition of research, Applications of research and types, Researchprocess 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. Research Modeling: Types of Models, Model building and stages, Data considerationand testing, Heuristic and Simulation modeling, Data collection methods, Surveys-types and method selection.

(9)

UNIT 5. Literature review- Need, Procedure- Search for existing literature, Review the literatureselected, Develop a theoretical and conceptual framework, Writing up the review, **Formulating a research problem**: Sources, Considerations, Steps in formulation of aproblem, 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. **(4)**

UNIT 6. .Research Proposal: Contents-Preamble, the problem, objectives, hypothesis to betested, 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 **(5)**

TERM WORK:

1. Minimum three exercises using a statistical software (like MINITAB / SYSTAT or similar) 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 3 levels 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 in front of the class. (The papers collected shall be different for each student.)

REFERENCE BOOKS:

1. 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

2. 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

3. Ranjit Kumar, (2006), Research Methodology- A Step-By-Step Guide for Beginners, (Pearson Education, Delhi) ISBN: 81-317-0496-3

4. Trochim, William M.K., (2003), 2/e, Research Methods, (Biztantra, Dreamtech Press, New Delhi), ISBN: 81-7722-372-0

5. Kothari, C.K., (2004), 2/e, Research Methodology- Methods and Techniques, (New Age International, New Delhi)

6. Ross, Philip J. (1996), 2/e, Taguchi Techniques for Quality Engineering, (McGraw Hill, New York)

7. Besterfield, Dale H. (2005), 3/e, Total Quality Management, (Pearson Education, New Delhi)

8. Krishnaswamy, K. N., Sivakumar, AppaIyer and Mathirajan, M. (2006), Management Research Methodology: Integration of Principles, Methods and Techniques (Pearson Education, New Delhi)

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 to Experimental Design, (2005), (John Wiley & Sons)

12. Hinkelmann&Kempthorne – Design & Analysis of Experiments, Vol. II- Advanced Experimental Design, (2005), (John Wiley & Sons)

13. Richard L. Shell & Ernest L. Hall - Handbook of Industrial Automation,– (Marcel Decker Inc.)

M.TECH (CAD/CAM/CAE) Semester– I

ELECTIVE II - 2. AUTOMATIC CONTROL ENGINEERING

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Credit : 03
Practical: 1 Hr/Week	Term Work: 25 mark

Course Objective

To study the fundamentals of control engineering theory.

UNIT 1. Introduction to Automatic Control Systems:-Basic definition, Structure of a feedbacksystems, closed loop and open loop control systems. Laplace Transformation, Building blocks and transfer functions of mechanical, electrical, thermal and hydraulic systems. Mathematical models of physical systems, control systems components. Systems with dead time, control hardware and their models, Electro-hydraulic valves, hydraulic servomotors, synchros, LVDT, electro-pneumatic valves, pneumatic actuators. **(8)**

UNIT 2. Basic characteristic of feedback control systems:-Stability, steady state accuracy,transient accuracy, disturbance rejection, insensitive and robustness, Basic models of feedback control systems:-Proportional, integral, derivative and PID, feed forward and multi loop control configurations, stability, concept of relative stability. **(8)**

UNIT 3. Root locus and frequency response methods, stability in frequency domain,frequency domain methods of design, compensation and their realization in time and frequency domain, improving system performance,.**(8)**

UNIT 4. Design of Lead lag compensators, OpAmp based and digital implementation of compensators, Tuning of process controllers. (**4)**

UNIT 5. Introduction to design, sample data control systems, stable variable analysis and design, optimal control systems. **(4)**

UNIT 6. Introduction to non linear control systems, discrete time systems and Z-Transformation methods, Microprocessor based digital control, State space analysis, Optimal and adaptive control systems. **(5)**

TERM WORK:

Term Work shall consist of four design/control problems solved using MATLAB and three assignments based on the above topics. Additional exercises using Bond Graphs for system modeling are desirable.

REFERENCE BOOKS:

1. F.H.Raven,"Automatic Control Engineering", Third edition, McGraw Hill, 1983.
2. K.Ogata,"Modern Control Engineering", PHI, Estern Economy Edition, 1982.
3. I.J.Nagrath, M.Gopal,"Control Systems Engineering".
4. B.C.Kuo, "Automatic Control Systems".

5. Schaum Series," Theory and Problems of Feedback and Control Systems". (MGH)
6. Miller R.W.,"Servo Mechanism Devices and Fundamentals".
7. Dr.N.K.Jain,"Automatic Control Systems Engineering", DhanpatRai Publishing Company.
8. Jack Golten, Andy Verwer, "Control System Design and Simulation", McGraw Hill

M.TECH (CAD/CAM/CAE) Semester– I

ELECTIVE II- 3. OPTIMIZATION TECHNIQUES

Teaching Scheme:

Lectures: 3 Hrs/ Week

Tutorial: 1 Hour per week

Examination Scheme:

Credit : 03

Term Work: 25 Marks

UNIT 1. Classical Optimization Techniques: Single-variable and Multi-variable Optimization,Hessian Matrix, Saddle Point, Lagrange Multipliers Method, Kuhn-Tucker Conditions **(3)**

UNIT 2.Single-variable Optimization Techniques: Unrestricted Search, Exhaustive Search,Dichotomous Search, Interval-halving Method, Fibonacci Method, Golden-section Method, Quadratic Interpolation Method, Newton Method, Quasi-Newton Method, Secant Method **(12)**

UNIT 3.Multi-variable Optimization Techniques: Evolutionary Optimization Method, SimplexSearch Method, Pattern Search Method, Conjugate Direction Method, Steepest Descent Method, Newton's Method, Conjugate Gradient Method, Davidon-Fletcher-Powell Method **(12)**

UNIT 4. Constrained Optimization Techniques: Interior Penalty Function Method, Exterior Penalty function Method **(4)**

UNIT 5. Search Techniques: Genetic Algorithm, Simulated Annealing, Artificial Neural Networks **(3)**

UNIT 6.Theory of Constraints: Introduction to TOC, Optimized Production Technology (OPT),Nine principles of OPT, Five Focusing Steps (The 5FS) of TOC, Capacity Constrained Resources and the Time Buffer, Modeling the Time Buffer, Modeling Return-On-Investment (ROI) in TOC, Comparison of TOC and Local Optimization Approaches **(3)**

TERM WORK

Minimum Six assignments based on the above syllabus.

REFERENCE BOOKS:

- Deb K (2004). Optimization for Engineering Design: Algorithms and Examples, Prentice Hall of India.
- Dennis J Jr, Schnabel R (1996). Numerical Methods for Unconstrained Optimization and Nonlinear Equations, Society for Industrial and Applied Mathematics.
- Rao S (1996). Engineering optimization, Theory and Practice, New Age International Publishers
- Ravindran A, Ragsdell K and Reklaitis G (2006). Engineering Optimization: Methods and Applications, 2nd edition, John Wiley and Sons Inc.
- Goldratt, E. M. and Cox, J. (2004). The Goal: A Process of Ongoing Improvement. 3rd Edition, North River Press. ISBN-10: 0884271781, ISBN-13: 978-0884271789
- Dettmer, H. William (1997). Goldratt's Theory of Constraints: A Systems Approach to Continuous Improvement, American Society for Quality. ISBN 0873893700, 9780873893701

M.TECH (CAD/CAM/CAE) Semester– I

ELECTIVE II - 4. TRIBOLOGY & SURFACE ENGINEERING

Teaching Scheme:

Lectures: 2 Hrs/ Week

Practical: 2 Hrs/ Week/ Batch

Examination Scheme:

Theory Paper (4 Hours): 100 marks

Term Work: 25 marks

SECTION I: TRIBOLOGY

UNIT 1. Friction Wear and Corrosion: Theory of friction- sliding and rolling friction, Tabor'smodel of friction, Friction properties of metallic and non metallic materials, friction in extreme conditions, Wear, types of wear, mechanisms of wear, wear resistant materials,
Mechanisms and types of corrosion, Measurement and testing of Friction, Wear and Corrosion, Prevention of wear and Corrosion. **(5)**

UNIT 2. Lubrication Theory: Lubricants and their physical properties, lubricants standards,Lubrication regimes, Hydrodynamic lubrication, Reynolds equation, Thermal, inertia and turbulent effects, Elasto, Plasto and magneto hydrodynamic lubrication, Hydrostatic, Gas lubrication. Design of fluid film bearings, Design of air bearing and gas bearing. **(9)**

UNIT 3.Tribo Measurement and Instrumentation: Surface topography measurements, Electronmicroscope, Laser method, Instrumentation, International Standards, Bearing
performance measurements, Bearing Vibration Measurement **(4)**

SECTION II: SURFACE ENGINEERING.

UNIT 4. Introduction to Surface Engineering: Concept and Scope of Surface Engineering,Mathematical modeling and manufacturing of surface layers, The solid surface-geometrical , mechanical and physico chemical concept, Three dimensional structure
of surface, The superficial layer and its parameters. **(4)**

UNIT 5. Surface Engineering for Wear and Corrosion Resistance: Diffusion Coatings, Electroand Electrolessplatings, Hot dip coating, Metal Spraying, Cladded coatings, Crystallizing coatings, Flame and arc processes, Conversion coatings, selection of coatings for wear and corrosion resistance, Potential properties and parameters of coatings. **(8)**

UNIT 6. Thin Layer Engineering Processes: Laser and electron beam hardening, its processparameters and their effects, Physical vapour deposition, Thermal evaporationArcvapourisation, Sputtering, Chemical vapour deposition, ion implantation technique,
Coating of tools, TiC, TiN, Al_2O_3 and Diamond coating properties, applications of thin
Coatings. **(8)**

TERM WORK

1. Measurement of Friction sliding / Rolling friction - case study
2. Measurement of wear of cutting tool
3. Measurement of corrosion – a case study.
4. Measurement of a bearing performance.
5. Study of general characteristics of superficial layer obtained by Machining.
6. Industrial visit to study techniques of coating – case study.
7. Case study of Physical Vapour deposition method.

8. Case study of Chemical vapour deposition method.

REFERENCE BOOKS:

1. Hulling J. " Principles of Tribology" McMillan, 1984
2. Williams J.A. "Engineering Tribology" Oxford University press, 1994.
3. Davis J. "Surface Engineering for corrosion and Wear Resistance", Woodhead Publishing, 2001.
4. TadauszBurakowski, "Surface Engineering of Metals: Principles, Equipments, Tehnologies" Taylor and Francis.

Web References:

1 http://www.csetr.org

2. http://www.bstsa.org

3. http://www.sea.org.

M.TECH (CAD/CAM/CAE) Semester– I

CAD/CAM Laboratory-I

Teaching Scheme:

Practical: 2 Hrs/ Week

Examination Scheme:

Credit : 02

Practical: 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- 1.The term- work will be accessed on the basis of completion of above assignments and submission of report.

2. Practical examination: Duration 3 hours, Candidate will carry out one exercise in modeling and one exercise in CNC part programming/ simulation/ manufacturing, followed by oral examination.

M.TECH (CAD/CAM/CAE) Semester– I
Design and Analysis Laboratory – I

Teaching Scheme:

Practical: 2 Hrs/ Week

Examination Scheme:

Credit : 02

Oral / Practical: 25 marks

Minimum eight assignments are to be completed on following area using appropriate software.

1. Structural Analysis
2. Thermal Analysis
3. Fluid Flow Analysis
4. Coupled Field Analysis
5. Modal Analysis

- Minimum two problems shall be solved with hand calculations.
- In addition to above a visit to some facility where any of the above is actually used to prepare report of the same.
- Term work shall be assessed on the basis of completion of above assignments and submission of reports.
- Practical examination: Duration 3 hours – Each candidate shall carry out analysis using suitable FEA software followed by oral examination.

M.TECH (CAD/CAM/CAE) Semester– I

8. Seminar – I

Teaching Scheme:

Examination Scheme:

Practical: 1 Hour/ Week Credit: 02

Seminar - I should be based on the literature survey on any topic relevant to CAD/CAM/CAE. It may be leading to selection of a suitable topic of dissertation.

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 and endorsement of the Head of Department.

The student has to deliver a seminar talk in front of the teachers of the department and his classmates. The Guide based on the quality of work and preparation and understanding of the candidate shall do an assessment of the seminar.

M.TECH (CAD/CAM/CAE) Semester– II

1. MANUFACTURING SYSTEMS DESIGN

Teaching Scheme: **Examination Scheme:**

Lectures: 3 Hrs/ Week Credit : 03

Practical: 1 Hr/Week Term Work: 25 arks

UNIT 1.Fundamentals: System concept, Hierarchical structure, System design, Decisionmaking procedure, System types in manufacturing environments;

Manufacturing Systems: Structural aspects, transformational aspects, procedural aspects, integrated manufacturing systems; Modes of Production- Jobbing/Intermittent/ Continuous; Mass Production- Economies of Scale, Optimum production scale, Mass Customization; Multi-Product Small Batch Production- Economies of Scope with Diversification; Logistic Systems- Material flow: conversion / transportation / storage

(8)

UNIT 2.Product / Process Planning and Design: Product Life Cycle, Planning of a newproduct, Product Design Aspects, Design cost considerations, Concurrent Engineering; Process and Operation Design- Computer Aided Process Planning, Optimum routing analysis using Dynamic Programming and Network Techniques, Criteria for line balancing. **(5)**

UNIT 3.Manufacturing Optimization: Criteria for Evaluation, Optimization of single stage manufacturing- Unit production time and cost; Optimization of multistage manufacturing system- Scope, basic mathematical models; Cost Estimating- Classical metal cutting cost analysis, Industrial cost estimation practices, Estimating material, setup and cycle times. **(5)**

UNIT 4.Information Systems in Manufacturing: Database structures, hierarchical, network, Relational- concepts, keys, relational operations, query languages; Shop Floor Data Collection Systems- Types of data, on-line and off-line data collection, Automatic data collection systems.**(6)**

UNIT 5.Computer Simulation in Manufacturing System Analysis: Characteristics, SimulationModels, applications of probability and statistics.

Design and evaluation methodology of manufacturing systems, General design framework, Analysis of situation, Setting objectives, Conceptual modeling, Detailed design, Evaluation and Decision.**(7)**

UNIT 6.Modern approaches in Manufacturing: Cellular Manufacturing- Group Technology,Composite part, Rank Order Clustering Technique, Hollier method for GT cell layouts; Flexible Manufacturing- Concept, components, architecture; Lean Production-concept, principles, Agile Manufacturing- concept, principles and considerations for achieving agility. **(7)**

TERM WORK:

Minimum Six exercises from the following:

1. Case Study of a manufacturing system in a small / medium organization.
2. Exercise on Concurrent Engg., Optimum routing analysis, Line Balancing
3. Exercise on Optimization of Single stage / Multi stage manufacturing system
4. Cost estimation of manufacturing a medium complex component of an assembly.
5. Creation of a relational database for a module of a manufacturing system, use of a suitable query language and generation of reports
6. Exercise on designing and analysis of GT Cell layouts
7. Simulation and performance testing of a manufacturing system

REFERENCE BOOKS:

1. KatsudoHitomi, (1998), "Manufacturing Systems Engineering", Viva Low Priced Student Edition, ISBN 81-85617-88-0
2. B. Wu, "Manufacturing Systems Design & Analysis: Context and Techniques" (2/e), Chapman & Hall, UK, ISBN 041258140X
3. Mikell P. Groover, (2002), "Automation, Production Systems and Computer Integrated Manufacturing", (2/e), Pearson Education, ISBN 81-7808-511-9
4. Radhakrishan P., Subramaniyan S. and Raju V., "CAD / CAM / CIM", (3/E), New Age International Publication
5. Luca G. Sartori,(1998), " Manufacturing Information Systems", Addison Wesley Publishing Co.
6. N. Viswanadhan& Y, Narhari, (1998), "Performance Modeling of Automated Manufacturing Systems", Prentice Hall of India
7. Phillip F. Ostwald, JairoMunez, (2002), " Manufacturing Processes and Systems", John Wiley & Sons (Students' Edition), ISBN 9971-512-34-3
8. Sanjay B. Joshi, Jeffrey S. Smith ,(1994), "Computer Control of Flexible Manufacturing Systems: Research and Development", Springer, ISBN 0412562006, 9780412562006

M.TECH (CAD/CAM/CAE) Semester– II

2. COMPUTER AIDED MANUFACTURING

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Credit :03

Objective: To study advanced features of CAM so as to be capable of acceptingprofessional responsibilities and to understand the associativity between design and manufacturing.

UNIT 1. Introduction to CAM: - CNC machine tools, Principle of operation of CNC, Construction features including structure, drive system, tool-work movement actuation system, Work holding features, Tool holding features, Feedback system, machine control

system, 2D and 3D machining on CNC**(4)**

UNIT 2. CNC Part Programming - Detailed Manual part programming on Lathe and Machining centers using G & M codes, FAPT programming (FANUC)

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 tools and fixtures, use of pallets for work holding, palletizing of fixtures. **(12)**

UNIT 3. Advanced CNC processes - EDM, Wire cut M, Abrasive water jet, LASER cutting, (Working principles, construction or set up of process, applications) **(3)**

UNIT 4.Co-ordinate Measuring Machine – Working principle, Drives, Controls, Types and applications of CMM software and utilities; CMM Inspection routines for measuring straightness, roundness, concentricity, center distance and pitch circle diameters of holes, parallelism and perpendicularity of surfaces and bore axes etc. **(5)**

UNIT 5.Process planning using CNC machines: Differences with respect to conventional machines; Design for manufacturing and assembly - Concept with case studies, **(3)**

UNIT 6.Computer aided CNC part programming – Introduction to common CNC controllers like FANUC, SIEMENS, MAZAK etc., Generation of tool path, generation of G & M codes, Optimization of tool path (to reduce machining time), (Features available on a typical CAM software), **(4)**

REFERENCE BOOKS:

1. Jon Stenerson and Kelly Curran "Computer Numerical Control", Prentice-Hall of India 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 Hill
4. Reference Manuals of FANUC, Siemens, Mazak, etc.
5. Thomas M. Crandell "CNC Machining and Programming, Industrial Press ISBN-

0-8311-3118-7

6. Bedworth, Wolfe and Henderson – "Computer aided design and manufacturing" - McGraw Hill

7. A. Ghosh and Malik – "Manufacturing Science" Affiliated East West Press Pvt. Ltd.

8. Tilak Raj – "CNC Technology and Programming", DhanpatRai Publication Company.

9. Robert Quesada, T.Jeyapoovan "Computer Numerical Control: Machining and Turning Centers" , Pearson Education.

M.TECH (CAD/CAM/CAE) Semester– II

3. PRODUCT LIFE CYCLE MANAGEMENT

Teaching Scheme: **Examination Scheme:**

Lectures: 3 Hrs/ Week Credit: 03

Practical: 1 Hr/Week Term Work: 25 marks

UNIT 1.PRODUCT LIFE CYCLE ENVIRONMENT : Background, Overview, Need, Benefits, Concept of Product LifeCycle. Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement.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.**(9)**

UNIT 2. PRODUCT DEVELOPMENT PROCESS & METHODOLOGIES : Integrated Productdevelopment 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)**

UNIT 3.PRODUCT MODELLING : Product Modelling - Definition of concepts - Fundamentalissues - Role of Process chains and product models -Types of product models - model standardization efforts-types of process chains - Industrial demands. **(5)**

UNIT 4.TYPES OF ANALYSIS TOOLS : Design for manufacturing - machining - casting and metalforming - 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)**

UNIT 5.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)**

UNIT 6.RECENT ADVANCES: Intelligent Information Systems - Knowledge based product andprocess 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. ISBN 0071452303

2. Product Life Cycle Management - by AnttiSaaksvuori, AnselmiImmonen, Springer, 1st Edition (Nov.5, 2003)

3. Stark, John. *Product Lifecycle Management: Paradigm for 21st Century ProductRealisation*, Springer-Verlag, 2004. ISBN 1852338105

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. ISBN 0970035225

8. Clement, Jerry; Coldrick, Andy; & Sari, John. *Manufacturing Data Structures*, John Wiley & Sons, 1992. ISBN 0471132691

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. ISBN 013017534X

10. Crnkovic, Ivica; Asklund, Ulf; &Dahlqvist, AnnitaPersson. *Implementing andIntegrating Product Data Management and Software Configuration Management*, Artech House Publishers, 2003. ISBN 1580534988

11. Garwood, Dave. *Bills of Materials for a Lean Enterprise*, Dogwood Publishing Co., 2004. ISBN 0962111848

12. Fan, D. (Ed.), Virtual Reality for Industrial Applications, Springer.

M.TECH (CAD/CAM/CAE) Semester– II

ELECTIVE III – 4. NANOTECHNOLOGY

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs / Week	Credit: 03
Practical: 1 Hr. / week	Term Work: 25 marks

Course Objective:

To understand the concepts and context of MEMS and nanotechnology.

UNIT 1.Introduction: Micro-Electro-Mechanical Systems (MEMS), Microsystems and theirproducts, miniaturization, applications, mechanical MEMS, thermal MEMS, micro-opto electro-mechanical systems, magnetic MEMS, radio frequency (RF) MEMS, micro fluidic systems, bio and chemo devices, Nanotechnology – definition, nanoscale, consequences of the nanoscale for technology and society, need and applications of nano electromechanical systems (NEMS) **(4)**

UNIT 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 micromanufacturing, photolithography, photoresists, 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; Doping – diffusion, ion implantation; Etching – wet etching, dry etching;
Surface micromachining, bulk vs. surface micromachining; Wafer bonding – glass-frit,

anodic and fusion bonding; LIGA process and applications. **(8)**

UNIT 3.Microsensors and actuators: Sensing and actuation, Chemical sensors, Opticalsensors, Pressure sensors, Thermal sensors – thermopiles, thermistors, micromachined thermocouple probes, thermal flow sensors, MEMS magnetic sensor, Piezoelectric material as sensing and actuating elements – capacitance, piezomechanics, Piezoactuators as grippers, microgrippers, micromotors, microvalves, micropumps, microaccelerometers, microfluidics, shape memory alloy based optical switch, thermally activated MEMS relay, microspring thermal actuator, data storage cantilever.
(6)

UNIT 4.Microsystem Design: Design constraints and selection of materials, selection of manufacturing process, selection of signal transduction technique, electromechanical

system and packaging. **(4)**

UNIT 5.Nanomaterials: Molecular building blocks to nanostructures – fullerenes, nanoscaledbiomolecules, chemical synthesis of artificial nanostructures, molecular switches and logic gates, nanocomposites; Carbon nanotubes - structure, single walled, multi walled, properties of carbon nanostructures and their synthesis, Potential applications of nano-structures. **(8)**

UNIT 6.Nanofinishing Techniques: Abrasive flow machining, magnetic abrasive finishing,magnetorheological finishing, elastic emission machining, ion beam machining, chemical mechanical polishing, Nanomanipulation, Nanolithography, Top-down versus bottom –up assembly, Visualisation, manipulation and characterization at the
nanoscale; Applications - in Energy, Tribology, Informatics, medicine, etc**(8)**

TERM WORK

It shall consist of six exercises based on the syllabus.

REFERENCE BOOKS:

1. Bharat Bhushan (Ed.), (2004), Handbook of Nanotechnology, Spinger-Verlag Berlin Heidelberg 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), Micromanufacturing& Nanotechnology, Springer India Pvt. Ltd., ISBN: 978-81-8128-505-8 (Distributed by New Age International, New Delhi)

5. Nanosystems: Molecular Machinery, Manufacturing & Computation, K E Drexler, (Wiley), (1992), ISBN 0471575186

6. P.Rai- Choudhury, Handbook of Microlithography, Micromachining &Microfabrication, SPIE,1997.

7. David Ferry, Transports in Nanostructures, Cambridge University Press, 2000.

8. Poole, Charles & Owen, Frank J., - Introduction to Nanotechnology, Wiley (India) Pvt. Ltd. ISBN: 978-81-265-10993

9. Various Internet resources: www.nanotechweb.org, www.nano.gov, www.nanotec.org.uk

M.TECH (CAD/CAM/CAE) Semester– II

Elective II- 2. RAPID MANUFACTURING

Course Objective

To study the concepts and applications of rapid prototyping and rapid manufacturing.

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Credit: 03
Practical: 1 Hr/Week	Term Work: 25 marks

UNIT 1.Design Potential of Rapid Manufacturing: Definition of rapid manufacturing (RM), rapid prototyping (RP) and rapid manufacturing, areas of application.

Conventional design for manufacturing andassembly (DFM, DFMA), impact of RM on DFA and DFMA, Geometrical freedom, design complexity/ optimization, parts consolidation, body fitting customization and multiple assemblies manufactured as one, Customer input and customization, CAD environment for RM. **(5)**

UNIT 2.RM Processes: Liquid based processes, Powder based processes and Solid basedprocesses; RP Processes : Process overviews, STL file Generation, File Verification & Repair, Build File Creation, Part Construction, Part Cleaning and finishing, Process Strength & limitations, Classes of RP systems: 3D Printers, Enterprise Prototyping centers,

Direct digital tooling, Direct digital manufacturing, system classification, Stereo lithography, SL with photo polymerization, SL with liquid thermal polymerization, Selective Laser Sintering, Fused deposition modeling, Laminated object manufacturing,

Laser powder forming **(10)**

UNIT 3.Materials in RM: Issues, viscous flow, photo-polymerization, sintering, infiltration,mechanical properties, Materials for RM processes, Prototype properties: Material properties, color, dimensional accuracy, stability, surface finish, machinability, environmental resistance, operational properties; Functionally graded materials (FGM composites), processing technologies for FGMs, laser sintering, thermal and mechanical

properties of FGM, Deposition systems and applications, **(6)**

UNIT 4..Applications of RP & RM: Design, Concept Models, Form and fit checking, ErgonomicStudies, Functional testing, CAD data verification, Automotive applications- Parts of racing cars, Applications in Aerospace industry, Construction industry, Retail industry,

Archeology, Paleontology and forensic science, miniaturization. **(5)**

UNIT 5. Rapid Tooling: Mold making, Metal spraying, Rapid tooling for die, squeeze andpermanent mold casting, Rapid manufacturing of sheet metal forming tools, casting

pattern plates by rapid tooling, RP for series production investment casting. **(8)**

UNIT 6.Management Issues of RM: Machine costs for RM, material cost, labour cost,comparison of cost of RM with cost of injection molding; Cost of manufacturing by RM, overheads, stock and WIP, location and distribution, supply chain management in RM
(4)

TERM WORK

1. Two Assignments on 3SD modeling & STL File generation of industrial components.
2. Study of RP Processes and their parameters
3. Study of 3D printing & its applications
4. Assignment on use of rapid tooling for injection molds
5. Assignment on use of RP for reverse engineering

REFERENCES

1. Rapid Manufacturing: An Industrial Revolution for the Digital Age – Editors N. Hopkinson, R.J.M. Hague and P.M. Dickens, (2006) John Wiley & Sons, Ltd., ISBN-10 0-470-01613-2

1. T. A. Grimm & Associates, Users Guide to Rapid Prototyping, Society of Manufacturing Engineers (SME) ISBN 0872636976

2. Frank W. Liou, Rapid Prototyping & engineering applications, CRC Press, ISBN 978-0-8493-3409-2

3. Rapid Prototyping theory & practice, Manufacturing System Engineering Series, Ali K. Kamarani, Springer Verlag

4. Rapid Prototyping- case book, J. A. McDonalds, C. J. Ryall, Wiley Eastern

5. Rapid & Virtual Prototyping & applications, C. E. Bocking, AEW Rennie, Wiley Eastern

6. Carmen Gabriela BĂCILĂ*, Zoltan-Gabor BAKI-HARI, "The Main Applications of Rapid Tooling," RECENT, Vol. 8, nr. 3a(21a), November, 2007

7. ANNALS of the ORADEA UNIVERSITY. Fascicle of Management and Technological Engineering, Volume VI (XVI), 2007

8. John F. Wallace, David Schwam," Rapid manufacturing of sheet metal forming tools," Case Western Reserve University

9. A. Pereira, J.A. Pérez, J.L. Diéguez, G. Peláez and J.E. Ares, "Design and manufacture of casting pattern plates", by rapid tooling, *Archives of Materials Science, Vol. 29, No. 1-2, 2008* 63

10. Using RP for Series Production Investment Castings, Tom Mueller, Express Pattern

WEBSITES

1. **http:// www_rpl.stanford.edu**
2. **http:// home.utah.edu/**
3. **http:// www.me.psu.edu**
4. **http:// itri.loyola.edu/rp/02**
5. **http:// www.udri.udayton.edu/**

11. Mechanical Vibrations (Fourth Edition) – S SRao, Pearson Education
12. Fundamentals of Mechanical Vibrations – S Graham Kelly, McGraw-Hill
13. Mechanical Vibrations – G.K. Groover, Nemchand& Brothers, Roorkee.
14. Fundamentals of Machine Component Design – R. C. Juvinall

M.TECH (CAD/CAM/CAE) Semester– II

Elective III- 3.COMPUTATIONAL FLUID DYNAMICS

Teaching Scheme:

Examination **Scheme:**

Lectures: 3 Hrs/ Week Credit : 03

Practical: 1 Hr/Week Term Work: 25 arks

UNIT 1.Introduction: CFD as the third dimension of fluid mechanics. Numerical Discretization methods such as Finite Difference, FEM and FVM. Why FVM as preferred method in CFD. **(9)**

UNIT 2.Basic Equations of Fluid Dynamics: Potential flow , Nonlinear Potential flow , Inviscid flowsand viscous flows. Navier Stokes Equations. Primitive variable vs. conservation form. Dimensional form vs. Non dimensional form. **(6)**

UNIT 3. Numerical methods for Convection -Diffusion eqns: Upwinding and central difference schemes. Stability condition in terms of Courant number. **(9)**

UNIT 4. Numerical Methods for Inviscid Flows: Characteristic form of eqns . Flux difference splitting. Application to 2-D flows such as flow through a nozzle. **(7)**

UNIT 5. Numerical methods for Incompressible flows: The continuity eqn divergence constraint. Poisson eqn. for pressure. Schemes such as SIMPLE due to Patankar and Spalding. **(6)**

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.TECH (CAD/CAM/CAE) Semester– II

ELECTIVE III-4. QUALITY AND RELIABILITY ENGINEERING

Teaching Scheme:

Lectures: 3 Hrs/ Week

Practical: 1 Hr/Week

Examination Scheme:

Credit: 03

Term Work: 25 marks

SECTION I: QUALITY ENGINEERING

1. Concepts of Quality Engineering, Taguchi's Approach to Quality, On-line and Off-line Quality Control, Difference from Classical Approach, Quality Loss Function, System Design, Parameter Design, Tolerance Design, Causes of Variation,
Classification of Parameters, Parameter Design Strategy
Steps in Robust Design, Quality Characteristics and Objective Functions, Control Factors and their Levels, Noise Factors and Testing Conditions, Planning and Conducting the Experiment **(6)**

2. Response Surface Methodology – First- order and Second-order Models **(8)**

3. Crossed Array Experiments, Signal-to-Noise Ratios **(6)**

SECTION II: RELIABILITY ENGINEERING

4.The Reliability Function, Failure Rate, Hazard Rate, Bath-tub Curve, Relationship between Various Reliability Characteristics
Component Reliability, Mean-time-to-failure, Time-dependent Hazard Models – Constant-hazard, Linear-hazard, Nonlinear-hazard and Gamma Models **(6)**

5.System Reliability, Two-state Modeling, Series Models, Parallel Models, Series-parallel and Parallel-series Models, *k-out-of-m* Models, Standby Models, Non-series-parallel

Models, Fault-tree Approach to System Modeling **(10)**

6.Maintained Systems, Classification of Maintenance Activities: Breakdown, Preventive and Predictive Maintenance, Condition Monitoring, Maintainability and Availability,

Reliability-centered Maintenance **(4)**

TERM WORK

Minimum Six assignments based on the entire syllabus.

REFERENCE BOOKS

- Antony J (2003). Design and Experiments for Engineers and Scientists, Butterworth-Heinmann.
- Cochran W and Cox G (2000). Experimental Designs, 2nd edition, John Wiley and Sons Inc.
- Dean A and Voss D (2006). Design and Analysis of Experiments, Springer.
- Jeff Wu C and Hamada M (2000). Experiments: Planning, Analysis and Parameter Design Optimization, John Wiley and Sons Inc.
- Montgomery D (2001). Design and Analysis of Experiments, 5th edition, Wiley.
- Phadke, M (1989). Quality Engineering using Robust Design, Prentice Hall.
- Ross, P (1996). Taguchi Techniques for Quality Engineering, 2nd edition, McGraw Hill.
- Balgurusamy E (2003). Reliability Engineering, Tata McGraw Hill.
- Birolini A (2004). Reliability Engineering: Theory and Practice, 4th edition, Springer.
- Crowder M, Kimber A, Smith R and Sweeting T (1991). Statistical Analysis of Reliability Data, Chapman and Hall.
- Kumamoto H and Henley E (1996). Probabilistic Risk Assessment and Management for Engineers and Scientists, IEEE Press.

Pre-requisites for Quality and Reliability Engineering

Section I:

Experimental design fundamentals, Guidelines for designing experiments, Concepts of replication, blocking and randomization, Statistical techniques in experimentation, Sampling and sampling distributions, Confidence intervals, Inferences about means and variances.

Experiments with single factor, Analysis of variance, Fixed effect model – Parameter estimation, Model adequacy checking, Residual plots, Comparing treatment means, Designing and testing contrasts.

Factorial design, Two-factor factorial design, The 22 design and 23 design – Parameter estimation, Model adequacy checking.

Section II:

Probability – Concept, Definitions, Rules of probability, Bayesian theorem

Continuous distributions – Normal, Lognormal, Exponential, Gamma, Chi-squared, and Weibull distribution

Discrete distributions – Binomial, Poisson, and Negative binomial distribution

M.TECH (CAD/CAM/CAE) Semester– II

ELECTIVE IV. 1.DESIGN FOR MANUFACTURING AND ASSEMBLY

Teaching Scheme **Examination Scheme:**

Credit : 03

Course Prerequisites: Machine design, Design and Analysis of Experiments.

Objective

• The course is aimed at developing students to acquire skills to analyze product design and be able to design products that are easier to manufacture, assemble, service and more friendlier to environment, etc.

Expected outcome

Upon completion of this course, the student shall be able to:

• Have customer-oriented, manufacturing and life-cycle sensitive approach to product design and development, with product design principles and structured design methodologies.

• Have Methods and approaches for developing, implementing, and nurturing an effective DFM process within the firm.

UNIT I

Introduction

General design principles for manufacturability – strength and mechanical factors, evaluation method,

Process capability - Feature tolerances- Geometric tolerances-Assembly limits- Datum features-Tolerance stacks.

UNIT II

Factors influencing form Design

Working principle, Material, Manufacture, Design – Possible solutions – Materials choice – Influence of

materials on form design – form design of welded members, forgings and castings

UNIT III

Component Design – Machining Consideration

Design features to facilitate machining – drills - milling cutters – keyways – Doweling procedures, counter

sunk screws – Reduction of machined area – simplification by separation – simplification by amalgamation

– Design for Machinability –Design for accessibility – Design for assembly.

UNIT IV

Robust Design and Taguchi Method

Robust design - Design of experiments – Robust design process- Orthogonal arrays: Two level orthogonal

arrays, Three level orthogonal arrays, Combined inner and outer arrays.

UNIT V

Redesign for Manufacture and case studies

Design for economy, Identification of uneconomical design – Modifying the design –Computer Applications for DFMA – Case Studies.

Text Books

1. Harry Peck, "Design for Manufacture", Pittman Publication, 1983.
2. Karl T. Ulrich, Ateven D. Eppinger" Product Design and Development" Tata McGraw-Hill, 2003.

References

1. James G. Bralla, "Hand Book of Product Design for Manufacturing", McGraw Hill co., 1986.

2. Swift K.G., "Knowledge based design for manufacture, Kogan Page Ltd., 1987.

3. Boothroyd, G., (1994), Product Design for Manufacture and Assembly, Marcel Decker

Bralla, J.G., (1999), Design for Manufacturability Handbook, McGraw-Hill.

M.TECH (CAD/CAM/CAE) Semester– II

ELECTIVE-4 2.INDUSTRIAL AUTOMATION AND ROBOTICS

Teaching Scheme: **Examination Scheme:**

Lectures: 3 Hrs/ Week Credit : 03

UNIT 1.Introduction: Automated manufacturing systems, fixed /programmable /flexibleautomation, need; 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. **(7)**

UNIT 2.Transfer Lines: Fundamentals, Configurations, Transfer mechanisms, storage buffers, control, applications; Analysis of transfer lines without and with storage buffers. **(4)**

UNIT 3.Assembly Automation: Types and configurations, Parts delivery at workstations-Various vibratory and non-vibratory devices for feeding and orientation, Calculations of feeding rates, Cycle time for single station assembly machines and partially automated
systems; Product design for automated assembly. **(5)**

UNIT 4.Fundamentals of Industrial Robots: Specifications and Characteristics, Basic components, configurations, Criteria for selection, Various industrial applications.
Robotic Control Systems**:** Drives, Robot Motions, Actuators, Power transmissionsystems; Robot controllers, Dynamic properties of robots- stability, control resolution,
spatial resolution, accuracy, repeatability, compliance. **(9)**

UNIT 5. Robotic End Effectors and Sensors: Transducers and sensors- sensors in robotics andtheir classification, Touch (Tactile) sensors, proximity and range sensors, force and torque sensing, End Effectors- Types, grippers, Various process tools as end effectors; Robot-End effector interface, Active and passive compliance, Gripper selection and design. **(7)**

UNIT 6..Robot Programming: Lead through method, Robot program as a path in space,Methods of defining positions in space, Motion interpolation, branching; Textual robot programming languages. **(4)**

REFERENCE BOOKS:

1. Groover, M.P., (2004), "Automation, Production Systems & Computer Integrated Manufacturing" 2/e, (Pearson Edu.) ISBN: 81-7808-511-9
2. Morris, S.Brian (1994), "Automated Manufacturing Systems", (McGraw Hill) ISBN: 0-07-113999-0
3. Pessen, David W.(1990), "Industrial Automation, Circuit Design & Components", (John Wiley & Sons, Singapore)
4. Groover, M.P.; Weiss, M.; Nagel, R.N. &Odrey, N.G. "Industrial Robotics, Technology, Programming & Applications", (McGraw Hill Intl. Ed.) ISBN:0-07-024989-X
5. 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
6. Keramas, James G. (1998), " Robot Technology Fundamentals",(CENGAGE) ISBN: 981-240-621-2

M.TECH (CAD/CAM/CAE) Semester– II

Elective IV- 3. CAD/CAM/CAE APPLICATIONS IN METAL FORMING

Teaching Scheme:

Lectures: 3 Hrs/ Week

Practical: 1 Hr/Week

Examination Scheme:

Credit : 03

Term Work: 25 marks

Course Objective

To study the use of computers in metal forming operations: planning and optimization.

UNIT 1.Introduction:-Process Modeling, The finite element method, Solid formulation and hollow formation, metal forming and FEMMetal forming Processes:- Introduction, Metal forming operations as a system, Classification

and Description of metal forming processes, Casting process

Analysis and Technology in Metal Forming:- Introduction, Flow stress of metals, Frictionin metal forming, Temperatures in metal forming, Impression and closed die forging, Hot extrusion of Rods and Shapes, Cold forging and extrusion, Rolling of strip, plate and shapes, Drawing of Rod, wire, shapes and Tubes, Sheet metal forming, fine blanking **(9)**

UNIT2.Plasticity and Visco-plasticity: Introduction, Stress, strain and strain rate, The yieldcriteria, Equilibrium and Virtual work rate principle, Plastic potential and flow rate, Strain

Hardening, Effective stresses and Effective strain, Visco-plasticity. **(4)**

UNIT4.Method of Analysis: Introduction, Upper Bound method, Hills General Method, FEM
Analysis Technology in Metal Casting: Introduction, Castability of important Ferrousand Non- ferrous metal, Shrinkage, Effect of Temperature, Effect of composition.
Finite Element Method**:** Introduction, Finite Element Procedures, Elements and shapefunction, Element strain rate matrix, Elemental stiffness equation, Numerical integrations, Assemblage and Linear matrix solver, Boundary conditions, Direct / Iteration method,

Time investment and Geometry updating, Rezoning **(9)**

UNIT5.Plane – Strain Problems: Introduction, Finite Element formulation, Closed die forging

with flash, Sheet Rolling, Plate Bending, Side pressing.
Axi-symmetric Isothermal Forging**:** Introduction, Finite Element formation, Pre-formdesign method, Die design, Shell nosing at room temperature, Plane strain rolling, AxiallySymmetric forging**.**

UNIT6.Steady State Processes of Extrusion and Drawing: Introduction, Method of Analysis,Bar Extrusion, Bar Drawing, Multi pass bar drawing and Extrusion, Applications to process.
designSheet Metal Forming**:** Introduction, Plastic Anisotropy, In-plane deformation process,Axi-symmetric but of plane deformation, Axi-symmetric Punch stretching and deep drawing process, Sheet metal forming of General shapes, Square – cup drawingprocess.

Metal Casting: Introduction, Casting Design, FEA analysis, Die / pattern Design,
Casting Simulation – Gating Design, Die / Pattern manufacture **(10)**

TERM WORK

Minimum **Four** Exercises using suitable software packages for the simulation.

1. Forging simulation to predict die fill load, energy and defect formation for simple components
2. Extrusion simulation to validates design of extrusion dies and process, Simulation of metal flow and heat transfer
3. Casting simulation to predict fluid flow, hot spots- shrinkage, designing of Gating and rising
4. Forging pre-form and Die design and FEA
5. Casting Design and FEA
6. Sheet metal simulation for validating forming feasibility, predict blank sizing, minimizing material scrap, determine wrinkles, splits etc.

REFERENCE BOOKS

1. Mechanical Metallurgy (2/e)– by Dieter (McGraw Hill)
2. Metal Casting – Dr. B. Ravi – (Prentice Hall of India)

3. Metal Forming & Finite Element Method – by ShiroKobjashi Oxford University.

4. Technology of Metal Forming Processes, -Surender Kumar (EEE)(PHI)
5. Theory of Plasticity- AmitavChakraborty, McGraw Hill.

M.TECH (CAD/CAM/CAE) Semester– II

ELECTIVE-IV.4 INDUSTRIAL PRODUCT DESIGN

Lecture : 3 Hrs/week Credit : 03
Practical: 2 Hrs/week Term Work : 25 Marks

UNIT1. Introduction: Challenges of product development; Successful product,development Quality aspect of product design; Market Research; Survey. Identify customer needs and Product Planning Processes. Product specifications:Process of setting specifications. Concept generation–selection–testing. Product Architecture: Implication of architecture, establishing the architecture,related system level design issue. Industrial design : Overview**. (10)**
Design for manufacturing and assembly - tolerancing, design of gauges;
UNIT2. Designfor environment; Robust design. Prototyping; Engineering Materials. Concurrent engg.. Product costing, value engineering, Aesthetic concepts; visual effects of form and colour. Product data management.Innovation and Creativity in Product Design. Case Studies.
Ergonomics and Industrial Safety (EIS) (9)
UNIT 3. Introduction - General approach to the man-machine relationship-workstation designworkingposition and posture. An approach to industrial design - elements of design structure for industrial design in engineering applications in manufacturing systems.
8. Control and Displays: configurations and sizes of various controls and (2) displays;- design of controls in automobiles, machine tools etc., - design of instruments and controls.
UNIT 4 . Ergonomics and Manufacturing: Ergonomics and product design; ergonomics in (4) automated Systems; Anthropomorphic data and its applications in ergonomic design; limitations of anthropomorphic data - use of computerized database.(6)
UNIT 5. Safety & Occupational Health and Environment: Application of Ergonomics in (2) industry for Safety, Health and Environment Control. Prevention and specific safety measures for manufacturing and processing (3) industry – safety in the use of machines, precaution for certain chemical types of industry like foundry, process industry, chemical industry.
UNIT 6 . Environmental Safety and ISO 14000 Systems. Occupational Health – Health and Safety consideration; Personal protective (3) protective Equipment.

TERM WORK:

Eight assignments with case studies on above topics using modeling softwares like CATIA V5, ProE, SolidWorks and UniGraphics.

REFERENCES:

1. Product Design and Development: Karl T. Ulrich, Steven G. Eppinger; Irwin McGrawHill
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 Winston Knight.
5. Product Design : Otto and Wood; Pearson education.
6. Industrial Design for Engineers: Mayall W.H, London, Hiffee books Ltd, 1988
7. Applied Ergonomics, Hand Book: Brian Shekel (Edited) Butterworth Scientific, London 1988.
8. Introduction to ergonomics – R.C. Bridger, McGraw Hill Pub.
9. Human Factor Engineering – Sanders & McCormick, McGraw Hill Publications.
10. Product Design – Kevin Otto, Kristin Wood Pierson Education.
11.Noff, Shimon Y. "Handbook of Robotics", (John Wiley & Sons)

12.Niku, Saeed B. (2002), "Introduction to Robotics, Analysis, Systems & Applications" , (Prentice Hall of India)

13.Koren, Yoram "Robotics for Engineers", (McGraw Hill)
Schilling, Robert J.(2004), "Fundamentals of Robotics, Analysis & Control", (Prentice Hall of India), ISBN: 81-203-1047-0.

M.TECH (CAD/CAM/CAE) Semester– II

1. Compressive viva

Credit: 02

The students have to do preparation on all the subjects which they have studied in Ist and IInd semesters. The viva will be conducted by the external and internal examiners jointly and their appointments will be made by university. The thorough knowledge, preparation and subjects' understanding will be assessed by the Examiners.

M.TECH (CAD/CAM/CAE) Semester– II

Design & Analysis Laboratory - II

Teaching Scheme:

Practical 2 Hrs./Week

Examination Scheme:

Credit : 02

Practical/Oral Examination: 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)
5. Computational Fluid Dynamics (Optional)
6. A Composite project based on Exercises of Design & Analysis Laboratory I and II .

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

Practical Examination duration: 3 Hours

The candidate shall carry out analysis using suitable software package followed by oral examination.

M.TECH (CAD/CAM/CAE) Semester– II

8. SEMINAR – II

Teaching Scheme: **Examination Scheme:**

Practical: 1 Hour/ Week Credit: 02

Seminar - II should be based on the literature survey on any topic relevant to CAD/CAM/CAE. 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.

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 and endorsement of the Head of Department.

The student has to deliver a seminar talk in front of the teachers of the department and his classmates. The Guide based on the quality of work and preparation and understanding of the candidate shall do an assessment of the seminar.

M.TECH (CAD/CAM/CAE) Semester– III

1. Industrial Training

Examination scheme:Credit: 02

The student has to prepare the report of training undergone in the industry during vacation after semester II. It shall include the brief details of assignment completed by the candidate and general observation and analysis. The identified areas for undertaking the dissertation work shall form part of report. The term work marks should be based on report and departmental oral exams. The training should be of minimum two weeks from reputed industries and certificate of the same should be a part of the report.

M.TECH (CAD/CAM/CAE) Semester– III

DISSERTATION PHASE-I

Examination scheme: Credit: 04

The dissertation work to be carried out individually commences in the Semester III and extends through Semester IV. The topic of dissertation work related should be related to the areas of CAD/CAM/CAE applications. Applications of computer as a tool for conceptualization, design, analysis, optimization, manufacturing, manufacturing planning /management, quality engineering, simulation of products / processes / mechanisms / systems, experimental study, etc. are to be encouraged and preferred.

SYNOPSIS APPROVAL

The Head of the Department shall appoint a committee comprising of the Guide and two experts to review and approve the synopses before submitting them to the University for approval. The candidates shall submit the synopsis to the University authorities for approval in the prescribed format before the due date.

M.TECH (CAD/CAM/CAE) Semester– III

DISSERTATION PHASE II

Teaching Scheme: **Examination Scheme:**

Practical: 2 Hour/ Week **Credit :10**

It shall include the problem definition, literature survey, approaches for handling the problem, finalizing the methodology for the dissertation work and design calculations / experimental design etc. A report of the work shall be submitted at the end of Semester

IIIafter approval by the Guide and endorsement of the Head of Department. It will be assessed for term work, by the evaluation committee(*) appointed by the Head of the Department, for appropriateness, sufficiency of contents and offer suggestions if any.

M.TECH (CAD/CAM/CAE) Semester– IV

DISSERTATION PHASE III

Teaching Scheme:

Practical: 4 Hour/ Week

Examination Scheme:

Credit :08

Oral Examination: 100 Marks

The candidate shall submit the detailed report as per the synopsis approved by the university, of the dissertation work in the prescribed format after approval by the Guide and endorsement by the Head of the Department. It will be assessed for term work by the evaluation committee (*) appointed by the Head of the Department, for completion of the proposed work.

(*) **Note: The evaluation committee shall consist of the Guide, one senior expert faculty member and the Head of the Department or his/her representative.**

M.TECH (CAD/CAM/CAE) Semester– IV

DISSERTATION PHASE IV

Teaching Scheme: **Examination Scheme:**

Practical: 4 Hour/ Week **Credit :10**

The dissertation submitted by the student on topic already approved by university authorities on basis of initial synopsis submitted by the candidate, shall be according to 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 less than 60. Figures, graphs, annexure etc be as per the requirement. The report should be written in the standard format.

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 IEEE/ASME/ElsevierFormat)