Dr. Mahalingam College of Engineering and Technology
(An Autonomous Institution)
Pollachi - 642 003

Curriculum and Syllabus for

M.E. CAD/CAM

SEMESTER I to IV

REGULATIONS 2014 R

DR MAHALINGAM
MCET
COLLEGE OF ENGINEERING AND TECHNOLOGY
Enlightening Technical Minds

Dr. Mahalingam College of Engineering and Technology
(An Autonomous Institution)
Pollachi - 642 003
DEPARTMENT OF MECHANICAL ENGINEERING
Curriculum and Syllabus for M.E. – CAD/CAM
2014 R REGULATION
SEMESTER I

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
THEORY						
141CC0101	Advanced Mathematics	4	0	0	4	100
141CC0102	Computer Applications in Design	3	0	0	3	100
141CC0103	Mechanical Vibrations	4	0	0	4	100
141CC0104	CNC Machines and Robotics	3	0	0	3	100
141CC0105	Computer Aided Process Planning	3	0	0	3	100
XXXXXXXX	Elective-I	3	0	0	3	100
PRACTICAL						
141CC0107	CAM Laboratory	0	0	4	2	100
TOTAL		**20**	**0**	**4**	**22**	**700**

SEMESTER II

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
THEORY						
141CC0201	Finite Element Method	4	0	0	4	100
141CC0202	Applied Materials Engineering	3	0	0	3	100
141CC0203	Integrated Product and Processes Development	3	0	0	3	100
141CC0204	Design for Manufacture ,Assembly and Environment	3	0	0	3	100
XXXXXXXX	Elective-II	3	0	0	3	100
XXXXXXXX	Elective-III	3	0	0	3	100
PRACTICAL						
141CC0207	CAD and CAE Laboratory	0	0	4	2	100
TOTAL		**19**	**0**	**4**	**21**	**700**

OBE Coordinator
Mr.S.Madhusudhanan

BoS Convener
Dr.Rama Thirumurugan

BoS Chairman
Dr. I.Rajendran

SEMESTER III

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
THEORY						
XXXXXXX	Elective -IV	3	0	0	3	100
XXXXXXX	Elective - V	3	0	0	3	100
XXXXXXX	Elective - VI	3	0	0	3	100
PRACTICAL						
141CC0307	Project Work Phase I	0	0	12	6	200
TOTAL		**9**	**0**	**12**	**15**	**500**

SEMESTER IV

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
PRACTICAL						
141CC0408	Project Work Phase II	0	0	24	12	400
TOTAL		**0**	**0**	**24**	**12**	**400**

OBE Coordinator
Mr.S.Madhusudhanan

BoS Convener
Dr.Rama Thirumurugan

BoS Chairman
Dr. I.Rajendran

ELECTIVES

Course Code	Course Title	Hours / Week			Credits	Marks
		L	T	P		
141CC9111	Industrial Robotics and Expert Systems	3	0	0	3	100
141CC9112	Mechatronics System Design	3	0	0	3	100
141CC9113	Productivity Management and Re-Engineering	3	0	0	3	100
141CC9114	Micro Electro Mechanical Systems	3	0	0	3	100
141CC9115	Computational Fluid Dynamics	3	0	0	3	100
141CC9116	Modelling of Dynamic Systems	3	0	0	3	100
141CC9117	Design and Analysis of Thermal Systems	3	0	0	3	100
141CC9118	Enterprise Resource Planning	3	0	0	3	100
141CC9119	Flexible Competitive Manufacturing System	3	0	0	3	100
141CC9120	Optimization Techniques in Design	3	0	0	3	100
141CC9121	Design of Material Handling Equipment	3	0	0	3	100
141CC9122	Design of Hydraulic and Pneumatic Systems	3	0	0	3	100
141CC9123	Product Data Management	3	0	0	3	100
141CC9124	Engineering Fracture Mechanics	3	0	0	3	100
141CC9125	Combustion and Emission in engines	3	0	0	3	100
141CC9126	Advanced Tool Design	3	0	0	3	100
141CC9127	Modelling and Analysis of Manufacturing Systems	3	0	0	3	100
141CC9128	Metrology and Non Destructive Testing	3	0	0	3	100
141CC9129	Data Communication in CAD/CAM	3	0	0	3	100
141CC9130	Design of Automotive Systems	3	0	0	3	100
141CC9131	Advanced Mechanisms Design and Simulation	3	0	0	3	100
141CC9132	Tribology in Design	3	0	0	3	100
141CC9133	Advanced Strength of Materials	3	0	0	3	100
141CC9134	Mechanics of Composite Materials	3	0	0	3	100
141CC9135	Additive Manufacturing	3	0	0	3	100
141CC9136	Research Methodology	3	0	0	3	100
141CC9137	Welding Metallurgy	3	0	0	3	100

OBE Coordinator
Mr.S.Madhusudhanan

BoS Convener
Dr.Rama Thirumurugan

BoS Chairman
Dr. I.Rajendran

SEMESTER – I

Course Code : 141CC0101	Course Title: ADVANCED MATHEMATICS	
Core/Elective: Core	L : T : P : C	4:0:0:4
Type: Theory	Total Contact Hours:	60 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Solve the variational problems with boundary conditions.
2. Solve the system of linear equations and apply numerical techniques to evaluate integrals.
3. Apply numerical techniques to solve the partial differential equations.
4. Interpret the notion of sampling distributions and statistical techniques used in engineering problems.
5. Explain the systematic problem solving techniques using design of experiments.

UNIT I CALCULUS OF VARIATIONS **12**

Variation and its properties –Euler's equation – Functionals dependent on first and higher order derivatives - Functionals dependent on functions of several independent variables – Rayleigh Ritz method- Galerkin method.

UNIT II SYSTEM OF LINEAR EQUATIONS AND NUMERICAL INTEGRATION **12**

Solving the set of equations, Choleski method, Iterative methods, Relaxation method, Trapezoidal rule, Simpson's rules, Gaussian quadrature, Examples.

UNIT III HIGHER ORDER PARTIAL DIFFERENTIAL EQUATIONS **12**

Second order linear equations and their classification, Initial and boundary conditions, D'Alembert's solution of the wave equation. Separation of variables method to simple problems in Cartesian coordinates. Solutions with Bessel functions and Legendre functions. One dimensional diffusion equation and its solution by separation of Variables.

UNIT IV TEST OF HYPOTHESES **12**

Statistical hypothesis, Large sample test based on Normal distribution for single mean and difference of means, Tests based on t, Chi-square and F distributions for mean, variance and proportion, Contingency table (test for independent),Goodness of fit.

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UNIT V DESIGN OF EXPERIMENTS 12

Aim of Design of Experiments-Basic Principles of Experimental Design-Completely Randomized Design(CRD)-Analysis of Variance(AVOVA)- Randomized Design(RBD)-Latin Square Design(LSD)-Comparison of RBD and LSD.

Course Outcomes

At the end of the course students will be able to:

CO1: Solve the variational problems with boundary conditions.

CO2: Solve the system of linear equations & apply numerical techniques to evaluate integrals.

CO3: Apply numerical techniques to solve the Partial Differential Equations.

CO4: Interpret the notion of sampling distributions and statistical techniques used in engineering problems.

CO5: Explain the systematic problem solving techniques using design of experiments.

Text Books

1. Curtis F Gerald and Patrick O Wheatley, "Applied Numerical Analysis", Second Edition, PHI Learning Private Limited, New Delhi, 2012
2. T.Veerarajan, "Probability, Statistics and Random Process", 2nd Edition, Tata McGraw-Hill, New Delhi,2009

References

1. P.Kandasamy,K.Thilagavathy,K.Gunavathy, "Numerical Methods" S.CHAND, First Edition 1997.
2. Rajasekaran S, "Numerical Methods in Science and Engineering – A Practical Approach", Wheeler Publishing, Second Edition, 1999.
3. Dr.J.Ravichandran, "Probability and Statistics for Engineers", 1st Edition, Wiley-India, Reprint 2012.

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Course Code : 141CC0102	Course Title: COMPUTER APPLICATIONS IN DESIGN	
Core/Elective: Core	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Explain the computer graphics principles.
2. Explain the modeling and reverse engineering concepts.
3. Explain the design concepts of tooling.
4. Write interactive programs to generate graphics and to solve design problems.
5. Explain the CAD data exchange standard.

UNIT I INTRODUCTION TO COMPUTER APPLICATIONS IN NEW PRODUCT DESIGN **8**

Concept design – parametric sketching – constraints – computer graphics principles- 2D transformation, scaling, rotation – windowing, view ports – clipping – data exchange formats.

UNIT II COMPUTERS IN DESIGN **10**

Solid modeling of Mechanical components – associative features – Sheet metal components, nesting and development – plastic parts with draft and shrinkage allowance – Reverse engineering of components – assembly of parts – tolerance analysis – mass property calculations

UNIT III COMPUTERS IN TOOLING DESIGN **9**

Mould design – jigs and fixtures design – check for interferences – mechanism design and analysis – Rapid tooling

UNIT IV COMPUTERS IN DESIGN PRODUCTIVITY **9**

Customizing various software by using visual basic, pro/program, script, LISP etc to write applications like design of shafts, gears etc.,

UNIT V CAD STANDARDS **9**

Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange images- Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc. - Communication standards.

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Course Outcomes

At the end of the course students will be able to:

CO1: Explain the computer graphics principles such as transformation, scaling, rotation, windowing clipping for new product design

CO2: Explain the modeling and reverse engineering concepts for a given sheet metal and plastic parts.

CO3: Explain the design concepts of tooling for various mould, jigs and fixtures.

CO4: Write interactive programs to generate graphics and to solve design problems for a given mechanical components.

CO5: Explain the CAD data exchange standard for given 2D or 3D diagrams.

Text Books

1. Hughes, J. F., Van Dam, A., Foley, J. D., McGuire, M., Feiner, S. K., Sklar, D. F., & Akeley, K. (2014). Computer graphics: principles and practice. Pearson Education.
2. Ibrahim Zeid "CAD/CAM – Theory and Practice" – McGraw Hill, International Edition 2010.

References

1. Rao. P .N. "CAD/CAM: Principles and Applications" Tata McGraw Hill , Second Edition. 2004
2. Schlechtendahl, E. G, CAD – Data transfer for Solid Models, Springer Verlag, Berlin, 1989.
3. Donald Hearn and M Pauline Baker "Computer Graphics" Prentice Hall Inc 1992.

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Course Code : 141CC0103	Course Title: MECHANICAL VIBRATIONS	
Core/Elective: Core	L : T : P : C	4 : 0 : 0 : 4
Type: Theory	Total Contact Hours:	60 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Calculate dynamic parameters for single degree of freedom system
2. Calculate dynamic parameters for two degree of freedom system
3. Calculate dynamic parameters for multi degree of freedom system
4. Derive equations for continuous system
5. Describe vibration measurement techniques

UNIT I FUNDAMENTALS OF VIBRATION **11**

Introduction – Single degree freedom free vibration systems – Damped vibrations – Single degree freedom forced vibration with elastically coupled viscous dampers, System Identification from frequency response, Support motion, Duhamel's Integral – Impulse Response function – Virtual work – Lagrange's equation— Transient Vibration

UNIT II TWO DEGREE FREEDOM SYSTEM **11**

Free vibration of spring-coupled system – mass coupled system – Vibration of two degree freedom system – Forced vibration – Vibration Absorber – Vibration isolation.

UNIT III MULTI-DEGREE FREEDOM SYSTEM **15**

Normal mode of vibration – Flexibility Matrix and Stiffness matrix – Eigen values and eigen vectors – orthogonal properties – Modal matrix-Modal Analysis – Forced Vibration by matrix inversion – Modal damping in forced vibration – Numerical methods for fundamental frequencies

UNIT IV VIBRATION OF CONTINUOUS SYSTEMS **11**

Systems governed by wave equations – Vibration of strings – vibration of rods – Euler Equation for Beams – Effect of Rotary inertia and shear deformation – Vibration of plates.

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UNIT V EXPERIMENTAL METHODS IN VIBRATION ANALYSIS 12

Vibration instruments – Vibration exciters Measuring Devices – Analysis – Vibration Tests – Free and Forced Vibration tests. Examples of Vibration tests – Industrial, case studies.

Course Outcomes

At the end of the course students will be able to:

CO1: Develop mathematical model of damped and undamped single degree of freedom system.

CO2: Develop mathematical model of damped and undamped two degrees of freedom system.

CO3: Develop mathematical model of damped and undamped multiple degrees of freedom system.

CO4: Develop mathematical model of dynamic continuous systems.

CO5: Explain vibration measurement test is used for real time applications.

Text Books

1. Den Hartog, J.P, "Mechanical Vibrations," Dover Publications,2007.
2. Rao, S.S.," Mechanical Vibrations, "Pearson Education , 6th Edition, 2018

References

1. Thomson, W.T. – "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, 5th Edition, 2015
2. Rao, J.S., & Gupta, K. – "Ind. Course on Theory and Practice Mechanical Vibration", New AgeInternational (P) Ltd., 2015

Web References

- http://nptel.ac.in/courses/112103111/
- https://ocw.mit.edu/courses/mechanical-engineering/2-003sc-engineering-dynamics-fall-2011/mechanical-vibration/

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Course Code : 141CC0104	Course Title: CNC MACHINES AND ROBOTICS	
Core/Elective: Core	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Distinguish different CNC machines.
2. Explain the different part program of CNC Lathe.
3. Explain the different part program of CNC Machining centre.
4. Explain different parts of Robot.
5. Explain the Robot programming language.

UNIT I INTRODUCTION AND DESIGN FEATURES OF CNC MACHINES 9

Working principles of typical CNC lathes, turning centre, machining centre, CNC grinders, CNC gear cutting machines, wire cut EDM. Selection of CNC machine tools, structure, drive kinematics, gear box, main drive, selection of timing belts and pulleys, spindle bearings arrangement and installation. Re-circulating ball screws, linear motion guide ways, tool magazines, ATC, APC, chip conveyors tool turrets, pneumatic and hydraulic control system, Open loop and closed loop systems , microprocessor based CNC systems, description of hardware and software interpolation systems, spindle encoder.

UNIT II PART PROGRAMMING OF A CNC LATHE 9

Process planning, tooling, preset and qualified tools, typical tools for turning and machining centres. Axes definition, machine and workpiece datum, turret datum, absolute and incremental programming, tape codes, ISO and EIA codes, G and M functions, tool offset information, soft jaws, tool nose radius compensation, long turning cycle, facing cycle, constant cutting velocity, threading cycle, peak drilling cycle, part programming examples.

UNIT III MANUAL PART PROGRAMMING OF A MACHINING CENTRE 9

Co-ordinate systems, cutter diameter compensation, fixed cycles, drilling cycle, tapping cycle, boring cycle, fine boring, back boring cycle, area clearance programs, macro, parametric programming, part programming examples. CAD/CAM based NC programming, features of CAM packages.

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UNIT IV FUNDAMENTAL CONCEPT OF ROBOTICS AND ROBOT DRIVES 9

History, present status and future trends, robotics and automation, laws of robotics, robot definition, robotics system and robot anatomy, specification of robots, resolution, repeatability and accuracy of a manipulator. Power transmission systems and control robot drive mechanisms, mechanical transmission method, rotary-to-rotary motion conversion, rotary–to-linear motion conversion end effectors, types, gripping problem, remote - centered compliance devices, control of actuator in robot mechanisms. Sensors for robotic applications.

UNIT V TRANSFORMS AND KINEMATICS 9

Homogeneous co-ordinates, co-ordinate reference frames, homogeneous transformations for the manipulator, the forward and inverse problem of manipulator kinematics, motion generation, manipulator dynamics, robot programming.

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the construction and features of CNC machines.
CO2: Develop a part program to produce a component by CNC lathe.
CO3: Develop a part program to produce a component by CNC machining centre.
CO4: Explain the construction and features of Robot.
CO5: Develop a Robot program to handle a process.

Text Books

1. Radhakrishnan .P, "Computer Numerical Control CNC Machines" New central book agency, 2013.
2. Mikell .P. Groover, Mitchell weiss, Roger N Nagel G Odrey, "Industrial Robotics", Mc-Graw Hill book co, NY, 2012.

References

1. Yoram Koren, "Computer Control of Manufacturing Systems", Mc-Graw Hill book co, 2006.
2. Richard D Klafter, Thomas A cmielewski, Michael Negin, "Robotic engineering: an integrated approach", Eastern economy edition prentice hall Pvt. Ltd., 2011.

Web References

- http://nptel.ac.in
- https://mit.edu/courses/mechanical-engineering

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Course Code : 141CC0105	Course Title: COMPUTER AIDED PROCESS PLANNING	
Core/Elective: Core	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Manufacturing process.
- Computer aided manufacturing.

Course Objectives

The course is intended to:

1. Explains process planning and product planning and GT
2. Explain geometric modeling techniques, tolerance, and GT
3. Choose suitable process planning technique for the given part.
4. Explain different computer aided process planning systems
5. Explain integrated process planning system, selection process, and report generation.

UNIT I INTRODUCTION **9**

Introduction to Process Planning and Production Planning – Process Planning in the Manufacturing cycle - Process Planning and Concurrent Engineering, CAPP, Group Technology.

UNIT II PART DESIGN REPRESENTATION **9**

Design Drafting - Dimensioning - Conventional tolerance - Geometric tolerance - CAD - input / output devices - topology - Geometric transformation - Perspective transformation - Data structure - Geometric modelling for process planning - GT layout, GT- coding - The optiz system - The MICLASS system-CODE system.

UNIT III PROCESS ENGINEERING AND PROCESS PLANNING 9

Experienced, based planning - Decision table and decision trees - Process capability analysis – Process boundaries – Process parameters – Process optimization. Process Planning - Variant process planning - Generative approach - Forward and Backward planning, Input format, AI.

UNIT IV COMPUTER AIDED PROCESS PLANNING SYSTEMS **9**

Logical Design of a Process Planning - Implementation considerations -manufacturing system components, production Volume, No. of production families - CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP.

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UNIT V AN INTEGRATED PROCESS PLANNING SYSTEMS 9

Totally integrated process planning systems - An Overview – TIPPS Design philosophy-CAD Interface, Modulus structure – Interactive surface identification, Process knowledge-Description language - Data Structure, operation - Input and Display of CAD model-surface identification - select process- select process parameters- Report Generation-Testing results, Expert process planning.

Course Outcomes

At the end of the course students will be able to:

CO1: Explains process planning, product planning and Group technology for manufacturing process.

CO2: Explain part design representation and Group technology coding system for part design.

CO3: Choose suitable process planning technique for the given part.

CO4: Explain different computer aided process planning such as CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP for manufacturing a part.

CO5: Explain integrated process planning system, selection process, and report generation for manufacturing a part.

Text Books

1. Gideon Halevi and Roland D. Weill, " Principles of Process Planning ", A logical approach, Chapman & Hall, 1997
2. Tien-Chien Chang, Richard A.Wysk, "An Introduction to automated process planning systems ", Prentice Hall, 1985

References

1. Chang, T.C., " An Expert Process Planning System ", Prentice Hall, 1990
2. Nanua Singh, "Systems Approach to Computer Integrated Design and Manufacturing ", John Wiley & Sons, 1996.
3. Rao,P.N " Computer Aided Manufacturing ", Tata McGraw Hill Publishing Co., 2001

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Course Code : 141CC0107	Course Title: CAM LABORATORY	
Core/Elective: Core	L : T : P : C	0: 0: 4: 2
Type: Practical	Total Contact Hours:	60 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Write CNC programming to machine the mechanical components.

List of Experiments

1. Study exercise on CNC machines and Programming codes.
2. Write part program for simple facing operation and simulate by using CNC Tutor
3. Write part program for simple turning operation and simulate by using CNC Tutor
4. Write part program for box facing operation and simulate by using CNC Tutor
5. Write part program for box taper facing operation and simulate by using CNC Tutor
6. Write part program for box turning operation and simulate by using CNC Tutor
7. Write part program for box taper turning operation and simulate by using CNC Tutor
8. Write part program for multiple facing operation and simulate by using CNC Tutor
9. Write part program for multiple turning operation and simulate by using CNC Tutor
10. Write part program for external grooving operation and simulate by using CNC Tutor
11. Write part program for peek drilling operation and simulate by using CNC Tutor
12. Write part program for grooving and threading operation and simulate by using CNC Tutor
13. Write part program for profile milling operation and simulate by using CNC Tutor
14. Write part program for peck drilling operation and simulate by using CNC Tutor
15. Write part program for profile milling and circular picketing operation and simulate by using CNC Tutor
16. Write part program for profile milling and rectangular picketing operation and simulate by using CNC Tutor
17. Turning operation using EDGE CAM
18. Turning operation using EDGE CAM
19. Milling operation using EDGE CAM
20. Study exercise on study of Rotational Database, networking, image processing
21. Study exercise on study of computer aided measuring instruments

Course Outcomes

At the end of the course students will be able to:

CO1: Write CNC programming to machine the mechanical components.

Bos Chairman

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Semester II

Course Code : 141CC0201	**Course Title:** FINITE ELEMENT METHOD	
Core/Elective: Core	**L : T : P : C**	4:0:0:4
Type: Theory	**Total Contact Hours:**	60 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Convert physical problems into mathematical model and Solve the one dimensional structural problems.
2. Solve the 2D vector and scalar variable problems.
3. Determine the shape function, Jacobean matrix, element stiffness matrix for 2D Quadrilateral element.
4. Determine the natural frequencies and mode shapes of beams using finite element procedures.
5. Explain finite element procedure in problems involving Non - Linearity.

UNIT I INTRODUCTION & ONE-DIMENSIONAL PROBLEMS 12

Relevance of finite element analysis in design - Variational principles and methods – Weighted-Integral statements– Ritz method – Method of weighted residuals – Applications of FEA - Finite element modeling – Co-ordinates and shape functions - Potential energy approach – Galerkin's approach – One dimensional finite element models in Solid mechanics – Finite element model for beams

UNIT II TWO-DIMENSIONAL PROBLEMS 12

Poisson equation – Laplace equation – Weak form – Element matrices for triangular and rectangular elements Assembly– Conduction and convection heat transfer - Torsional cylindrical member – Transient analysis - Theory of elasticity– Plane strain – Plane stress – Axi-symmetric problems – Principle of virtual displacement

UNIT III ISOPARAMETRIC ELEMENTS 12

Introduction – Bilinear quadrilateral elements – Quadratic quadrilaterals – Hexahedral elements - Numerical integration – Gauss quadrature – Static condensation – Load considerations – Stress calculations

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UNIT IV STRUCTURAL DYNAMICS APPLICATIONS 12

Dynamic equations – Mass and damping matrices – Natural frequencies and modes – Reduction of number of DOF-response history – Model methods – Ritz vectors – Component mode synthesis – Harmonic response – Direct integration techniques – Explicit and implicit methods – Analysis by response spectra.

UNIT V NON-LINEAR PROBLEMS & ERROR ESTIMATES 12

Introduction – Material non-linearity – Elasto Plasticity – Plasticity – Visco plasticity – Geometric non-linearity – Large displacement – Error norms and convergence rates – H-refinement with adaptively – adaptive refinement

Course Outcomes

At the end of the course students will be able to:

CO1: Convert physical problems into mathematical model using finite element procedure to solve one dimensional structural problems like such as bar, truss and beam

CO2: Solve the two dimensional vector and scalar variable problems by applying plane stress, strain, and axi-symmetric conditions using CST element.

CO3: Determine the shape function, Jacobean matrix, element stiffness matrix for 2D Quadrilateral element and find out the coordinates of a point in an element by applying Numerical integration and Gauss quadrature

CO4: Determine the natural frequenciesand mode shapes of beams using finite element procedures

CO5: Explain finite element procedure in problems involving Non - Linearity

Text Books

1. Logan D.L, "A First Course in the Finite Element Method", Fifth Edition, Thomson Learning, 2012
2. Segerlind L.J., "Applied Finite Element Analysis", John Wiley, 1984

References

1. Reddy J.N.,"An Introduction to the Finite Element Method",McGraw Hill, International Edition,2005
2. Cook, Robert Davis et al "Concepts and Applications of Finite Element Analysis", Wiley, John & Sons, 1999.
3. Zienkiewicz, O.C. and Taylor, R.L., "The Finite Element Method", Fourth Edition, Volumes 1 & 2, McGraw Hill International Edition, Physics Services, 1991

Bos Chairman

Course Code : 141CC0202	Course Title: APPLIED MATERIALS ENGINEERING	
Core/Elective: Core	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Explain the elastic, plastic behaviours of different materials
2. Explain the acceptable level of risk for a particular component.
3. Select a suitable material
4. Explain the properties of modern metallic materials
5. Explain the properties of non metallic materials

UNIT I ELASTIC AND PLASTIC BEHAVIOUR 10

Elasticity in metals and polymers - Mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals - Strengthening mechanisms, work hardening, solid solution strengthening, grain boundary strengthening, poly phase mixture, precipitation, particle, fiber and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviors - Super plasticity - Deformation of non-crystalline material.

UNIT II FRACTURE BEHAVIOUR 10

Griffith theory, stress intensity factor and fracture toughness - Toughening mechanisms - Ductile, brittle transition in steel - High temperature fracture, creep - Larson-Miller parameter - Deformation and fracture mechanism maps - Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law - Effect of surface and metallurgical parameters on fatigue - Fracture of non metallic materials - Failure analysis, sources of failure, procedure of failure analysis.

UNIT III SELECTION OF MATERIAL 10

Motivation for selection, cost basis and service requirements - Selection for mechanical properties, strength, toughness, fatigue and creep - Selection for surface durability corrosion and wear resistance Relationship between materials selection and processing - Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications.

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UNIT IV MODERN METALLIC MATERIALS 7

Dual phase steels, Micro alloyed, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) steel, Maraging steel - Intermetallics, Ni and Ti aluminides - Smart materials, shape memory alloys - Metallic glass - Quasi crystal and nano crystalline materials.

UNIT V NON METALLIC MATERIALS 8

Polymeric materials - Formation of polymer structure - Production techniques of fibers, foams, adhesives and coatings - Structure, properties and applications of engineering polymers - Advanced structural ceramics, WC, TiC, TaC, Al2O3, SiC, Si3N4, CBN and diamond - properties, processing and applications.

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the elastic, plastic behaviours of different materials and to utilize basic properties of materials to solve problems related to isotropic elasticity.

CO2: Explain the acceptable level of risk for a particular component or application subjected to fracture, fatigue and the relation with its microscopic mechanism of deformation.

CO3: Select a suitable material to meet the design specification by evaluating the relationship between material properties, microstructures and processing.

CO4: Explain the properties of modern metallic materials and its need for the emerging engineering application.

CO5: Explain the properties of non metallic materials used for a specific engineering application.

Text Books

1. Flinn, R.A. and Trojan, P.K., " Engineering Materials and their Applications ", (7th Edition), Jaico, 2002.
2. George E.Dieter, "Mechanical Metallurgy ", McGraw Hill, 3rd edition 2017.

References

1. Thomas H.Courtney, "Mechanical Behaviour of Materials ", (2nd Edition), McGraw-Hill, 2000.
2. Charles J.A., Crane, F.A.A and Furness, J.A.G., "Selection and use of Engineering Materials ", (3rd Edition), Butterworth-Heiremann, 1997.

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Course Code : 141CC0203	Course Title: INTEGRATED PRODUCT AND PROCESSES DEVELOPMENT	
Core/Elective: Core	L : T : P : C	3: 0: 0: 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Computer Applications in Design

Course Objectives

The course is intended to:

1. Explain product development process
2. Discuss product planning process
3. Explain product specifications
4. Analyze the concept selection and concept testing
5. Explain product architecture

UNIT I INTRODUCTION 9

Characteristics of Successful Product Development-Interdisciplinary activity-Duration and Costs of Product Development- Challenges of Product Development -Development Processes and Organizations-A Generic Development Process-Concept Development: The Front-End Process Adapting the Generic Product Development Process- The AMF Development Process-Product Development Organizations-The AMF Organization

UNIT II PRODUCT PLANNING 9

Product Planning Process- Identifying Opportunities- Evaluating and Prioritizing Projects-Allocating Resources and Timing- Pre-Project Planning-Reflect on the Results and the Process-Identifying Customer Needs- Raw Data from Customers- Interpreting Raw Data in Terms of Customer Needs-Organizing the Needs into a Hierarchy-Establishing the Relative Importance of the Needs-Reflecting on the Results and the Process

UNIT III PRODUCT SPECIFICATIONS 9

Specifications - Specifications Established - Establishing Target Specifications-Setting the Final Specifications-Concept Generation-The Activity of Concept Generation-Clarify the Problem- Search Externally-Search Internally-Explore Systematically- Reflect on the Results and the Process.

UNIT IV CONCEPT SELECTION 9

Concept Selection- Overview of Methodology-Concept Screening-Concept Testing-Define the Purpose of the Concept Test- Choose a Survey Population- Choose a Survey Format-Communicate the Concept-Measure Customer Response-Interpret the Results- Reflect on the Results and the Process

Bos Chairman

UNIT V PRODUCT ARCHITECTURE 9

Product Architecture-Implications of the Architecture-Establishing the Architecture-Delayed Differentiation-Platform Planning-Related System-Level Design Issues

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the product development process in various organizations.
CO2: Discuss product planning process and identify customer needs.
CO3: Explain product specifications and concept generation in product planning.
CO4: Analyze the concept selection and concept testing for various products.
CO5: Explain various product architecture and address design level issues.

Text Books

1. Product Design and Development, Karl T. Ulrich and Steven .D Epinger , McGraw-Hill International Edns. 2015.
2. Kevien Otto and Kristin Wood, "Product Design" Pearson Publication, 2011.

References

1. Tool Design – Integrated Methods for successful Product Engineering, Stuart Pugh, Addison Wesley Publishing, Neyourk, NY, 2014, ISBN 0-202-41639-5.
2. Effective Product Design and Development, Stephen Rosenthal, Business One Orwin, Homewood, 2014,ISBN, 1-55623-603-4.
3. Concurrent Engg. /Integrated Product Development. Kemnneth Crow, DRM Associates, 26/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book, 2013.

Bos Chairman

Course Code : 141CC0204	Course Title: DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENT	
Core/Elective: Core	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Explain the design principles for manufacturability
2. Describe the factors influencing form design
3. Explain the machining consideration while design
4. Optimize the given casting part.
5. Explain the environmental consideration in design.

UNIT I INTRODUCTION **8**

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

UNIT II FACTORS INFLUENCING FORM DESIGM **10**

Influence of materials on form design - form design of grey iron, malleable iron, steel and aluminium castings - form design of welded members, forgings

UNIT III COMPONENT DESIGN - MACHINING CONSIDERATION **9**

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly.

UNIT IV COMPONENT DESIGN-CASTING CONSIDERATION **9**

Redesign of castings based on parting line considerations, minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of un economical design-Modifying the design-group technology-Computer applications of DFMA

Bos Chairman

UNIT V DESIGN FOR THE ENVIRONMENT 9

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

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the design principles for manufacturability considering strength, process capability and tolerances.

CO2: Describe the factors influencing form design of castings, forgings and welding.

CO3: Explain the machining consideration while design such as machinability, economy, clampability, accessibility and assembly.

CO4: Optimize the given casting part by applying design principles.

CO5: Explain the environmental consideration in design while using DFMA tools.

Text Books

1. Boothroyd, G, Design for Assembly Automation and Product Design, Marcel Dekker, New York., 2005.
2. Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight , "Product Design for Manufacture and Assembly", Third Edition, CRC Press, 2010

References

1. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994
2. Dickson, John. R, and Corroda Poly, "Engineering Design and Design for Manufacture and Structural Approach", Field Stone Publisher, USA, 1999.
3. Fixel, J. "Design for the Environment" McGraw hill., 2011

Bos Chairman

Course Code : 141CC0207	Course Title: CAD AND CAE LABORATORY	
Core/Elective: Core	L : T : P : C	0: 0 : 4 : 2
Type: Practical	Total Contact Hours:	60 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Develop part models and Prepare assembly drawings
2. Apply finite element simulation software

List of Experiments

1. Preparation of Knuckle joint assembly drawing
2. Preparation of Flange coupling assembly drawing
3. Preparation of Screw Jack assembly drawing
4. Preparation of Universal Coupling assembly drawing

Analysis (Simple Treatment Only)

1. Stress analysis of beams (Cantilever, Simply supported, Fixed ends)
2. Stress analysis of a plate with a circular hole.
3. Mode frequency analysis of beams(Cantilever, Simply supported, Fixed ends)
4. Thermal stress analysis of a 2D component

Course Outcomes

At the end of the course students will be able to:

CO1: Develop part models and prepare assembly drawings of machine components using modelling software.

CO2: Apply finite element simulation software to solve structural, thermal and vibration problems in mechanical engineering.

Bos Chairman

Course Code : 141CC0307	**Course Title:** Project Work Phase I	
Core/Elective: Core	**L : T : P : C**	0: 0 : 12 : 6
Type: Practical	**Total Contact Hours:**	180 Hours

Course Objective

The course is intended to

1. Take up any challenging practical problems and find solution by formulating proper methodology.
2. Work individually to successfully complete a design project.
3. Effectively communicate the results of projects in a written and oral format.

The goal of this course is to help students to identify innovative projects that promote creativity to explore the variables that affect creativity and innovation. By the end of the semester, the students should be familiar with current thinking in their field, and able to apply the concepts to relevant research problems or practical applications. The goal of this course is to drive them to learn concepts, models, frameworks, and tools that engineering graduates' need in a world where creativity and innovation is fast becoming a precondition for competitive advantage. Each student will choose a frequently/commonly encountered workplace problem or socially relevant problems that have been difficult for them to "solve." At the end of the semester, each student has to submit a report for evaluation.

Course Outcomes

At the end of the course students will be able to:

CO1: Take up any challenging practical problems and find solution by formulating proper methodology.

CO2: Work individually to successfully complete a design project.

CO3: Effectively communicate the results of projects in a written and oral format

Bos Chairman

Course Code : 141CC0408	**Course Title:** Project Work Phase II	
Core/Elective: Core	**L : T : P : C**	0: 0 : 24 : 12
Type: Practical	**Total Contact Hours:**	360 Hours

Course Objectives

The course is intended to:

1. Take up any challenging practical problems and find solution by formulating proper methodology.
2. Work individually to successfully complete a design project.
3. Effectively communicate the results of projects in a written and oral format.

A student individually works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of four reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report.

Course Outcomes

At the end of the course students will be able to:

CO1: Take up any challenging practical problems and find solution by formulating proper methodology.

CO2: Work individually to successfully complete a design project.

CO3: Effectively communicate the results of projects in a written and oral format.

Bos Chairman

ELECTIVES

Course Code : 141CC9111	**Course Title:** INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS	
Core/Elective: Elective	**L : T : P : C**	3:0:0:3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Explain the fundamentals of robots.
2. Describe the working of robot drive systems
3. Discuss the working principle of sensors.
4. Explain the implementation of robots
5. Explain the concepts of robot programming.

UNIT I INTRODUCTION AND ROBOT KINEMATICS **10**

Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – Classifications of Robots. Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

UNIT II ROBOT DRIVES AND CONTROL **9**

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

UNIT III ROBOT SENSORS **9**

Transducers and Sensors – Sensors in Robot – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Gribbing – Image processing and analysis – Image segmentation – Pattern recognition – Training of vision system.

Bos Chairman

UNIT IV ROBOT CELL DESIGN 9

Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis - Industrial application of robots.

UNIT V ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPORT SYSTEMS 8

Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation. Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques - Application of Artificial Intelligence in Robots

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the fundamentals robot kinematics for forward and reverse motion.

CO2: Describe the working of robot drive systems for position, Velocity and end effectors.

CO3: Discuss the working principle of position, force, tactile and image sensors used in robots.

CO4: Explain the implementation of robotics in industries.

CO5: Explain the concepts of robot programming with Artificial intelligence.

Text Books

1. Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey," Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int. 2014
2. Timothy Jordanides et al ,"Expert Systems and Robotics " Springer –Verlag,New York, May 1991.

References

1. Fu. K.S., Gonzalez. R.C. and Lee. C.S.G., "Robotics Control, Sensing, Vision and Intelligence",Mc Graw Hill, 1987.
2. Yoram Koren," Robotics for Engineers' Mc Graw-Hill, 1985.

Bos Chairman

Course Code : 141CC9112	Course Title: MECHATRONICS SYSTEM DESIGN	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Describe the basics of Mechatronics systems.
2. Classify various sensors.
3. Describe the role of Microcontroller.
4. Describe the role of PLC in Mechatronics systems.
5. Analyze different type of automation systems.

UNIT I INTRODUCTION 3

Introduction to Mechatronics - Systems - Mechatronics in Products - Measurement Systems - Control Systems - Traditional design and Mechatronics Design.

UNIT II SENSORS AND TRANSDUCERS 12

Introduction - Performance Terminology - Displacement, Position and Proximity - Velocity and Motion - Fluid pressure - Temperature sensors - Light sensors - Selection of sensors - Signal processing - Servo systems.

UNIT III MICROPROCESSORS IN MECHATRONICS 15

Introduction - Architecture - Pin configuration - Instruction set - Programming of Microprocessors using 8085 instructions - Interfacing input and output devices - Interfacing D/A converters and A/D converters –Applications - Temperature control - Stepper motor control - Traffic light controller.

UNIT IV PROGRAMMABLE LOGIC CONTROLLERS 8

Introduction - Basic structure - Input / Output processing - Programming -Mnemonics Timers, Internal relays and counters - Data handling - Analog input / output - Selection of PLC.

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UNIT V DESIGN AND MECHATRONICS 7

Designing - Possible design solutions - Case studies of Mechatronics systems

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the fundamentals of mechatronics systems with block diagram.
CO2: Select sensors for various measurements including position, pressure, velocity, temperature and light used in different systems
CO3: Write a programme for temperature, stepper motor and traffic light signals by using Microcontroller.
CO4: Write a logical programme for real time applications using PLC
CO5: Design an automation system using Mechatronics principles.

Text Books

1. Michael B.Histand and David G. Alciatore, "Introduction to Mechatronics and MeasurementSystems", McGraw-Hill International Editions, 2007
2. Ramesh.S, Gaonkar, " Microprocessor Architecture, Programming and Applications, "Wiley Eastern, 2002

References

1. Bradley, D.A., Dawson, D, Buru, N.C. and Loader, A J., " Machatronis ", Chapman and Hall, 1993
2. Lawrence J.Kamm," Understanding Electro-Mechanical Engineering, An Introduction to Mechatronics ", Prentice-Hall, 1996

Bos Chairman

Course Code : 141CC9113	Course Title: PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites:

The student should have undergone the course:

- Nil

Course Objectives:

The course is intended to:

1. To study the concept of productivity, its measurement and organizational transformation.
2. To study the principles of Re-engineering.

UNIT I PRODUCTIVITY 9

Productivity Concepts – Macro and Micro factors of productivity – Dynamics of Productivity - Productivity Cycle Productivity Measurement at International, National and Organization level - Productivity measurement models.

UNIT II SYSTEMS APPROACH TO PRODUCTIVITY MEASUREMENT 9

Conceptual frame work, Management by Objectives (MBO), Performance Objectivated Productivity (POP) – Methodology and application to manufacturing and service sector- Modes of engineering services and manufacturing companies certification.

UNIT III ORGANISATIONAL TRANSFORMATION 9

Elements of Organizational Transformation and Reengineering-Principles of organizational transformation and re-engineering, fundamentals of process re-engineering, preparing the workforce for transformation and re-engineering, methodology, guidelines, LMI CIP Model – DSMC Q & PMP model.

UNIT IV RE-ENGINEERING PROCESS IMPROVEMENT MODELS 9

PMI models, PASIM Model, Moen and Nolan Strategy for process improvement, LMICIP Model, NPRDC Model.

UNIT V RE-ENGINEERING TOOLS AND IMPLEMENTATION 9

Analytical and process tools and techniques – Information and Communication Technology – Implementation of Reengineering Projects – Success Factors and common implementation Problem – Cases.

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Course Outcomes

At the end of the course students will be able to:

CO1: Define the concepts of basic Productivity.
CO2: Explain the Productivity Measurement Approaches of the Organizations.
CO3: Explain the principles of organizational transformation and re-engineering.
CO4: Define and understand the various Process Improvement Models of Reengineering.
CO5: Explain the various Re-Engineering Tools and techniques for Project implementation.

Text Books

1. Sumanth, D.J., „Productivity Engineering and Management", TMH, New Delhi, 1990.
2. Edosomwan, J.A., "Organisational Transformation and Process Re-engineering", Library Cataloging in Pub. Data, 1996.
3. Premvrat, Sardana, G.D. and Sahay, B.S., "Productivity Management – A Systems Approach", Narosa Publishing House. New Delhi, 1998.

References

1. Martand Telsang, "Industrial engineering and production management" S chand and company, New Delhi India 5th Edition, 2012
2. Michael Hammer, "The Re-engineering Revolution Handbook, "Herper – Collins Publishers,London, UK, 2000.

Bos Chairman

Course Code : 141CC9114	Course Title: MICRO ELECTRO MECHANICAL SYSTEMS	
Core/Elective: Elective	**L : T : P : C**	3:0:0:3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Explain the properties and functions of microsystems and microelectronics.
2. Explain the concept of various micro fabrication process
3. Explain the concept of micromechanics used for MEMS
4. Describe the principles of different micro machining and packaging process
5. Explain the principles and applications of Micro Electro Mechanical Systems

UNIT I INTRODUCTION **9**

Overview-Microsystems and microelectronics - Working principle of Microsystems -micro actuation techniques-microsensors-types-microactuators-types-micropump-micromotors-micro-valves-microgrippers-scaling laws-scaling in geometry-scaling in rigid body dynamics- scaling in electrostatic forces- scaling in electricity- scaling in fluid mechanics-scaling in heat transfer.

UNIT II MATERIALS AND FABRICATION PROCESS **9**

Substrates and wafer-single crystal silicon wafer formation-ideal substrates-mechanical properties-silicon compounds - Sio2, SiC, Si3N4 and polycrystalline silicon - Silicon piezoresistors - Gallium arsenide, Quartz-piezoelectric crystals-polymers for MEMS - conductive polymers – Photolithography - Ion implantation - Diffusion – Oxidation –CVD - Physical vapor deposition - Deposition by epitaxy - etching process

UNIT III MICROMECHANICS **9**

Introduction-static bending of thin plates-circular plates with edge fixed - rectangular plate with all edges fixed and square plate with all edges fixed – Mechanical vibration-resonant vibration- micro accelerometers-design theory and damping coefficients- thermo mechanics-thermal stresses-fracture mechanics-stress intensity factors, fracture toughness and interfacial fracture mechanics.

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UNIT IV MICRO SYSTEM MANUFACTURING 9

Clean room technology-Bulk Micro manufacturing- surface micro machining –LIGA-SLIGA-Micro system packaging-materials-die level-device level-system level-packaging techniques-die preparation-surface bonding-wire bonding-sealing

UNIT V MICRO SYSTEM DESIGN 9

Design considerations-process design-mask layout design- mechanical design-applications of micro system in -automotive industry-bio medical –aero space-telecommunications

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the properties and functions of microsystems and microelectronics
CO2: Explain the concept of various micro fabrication process
CO3: Explain the concept of micromechanics used for MEMS
CO4: Describe the principles of different micro machining and packaging process
CO5: Explain the principles and applications of Micro Electro Mechanical Systems

Text Books

1. Mohamed Gad-el-Hak, The MEMS Hand book, CRC press 2005
2. Tai-Ran Hsu,MEMS & Microsystems Design and Manufacture, Tata McGraw-Hill,2006.

References

1. Julian W.Gardner,Vijay K.Varadan,Osama O.Awadel Karim,Microsensors MEMS and Smart Devices, John Wiby & sons Ltd.,2001
2. S.Fatikow,U.Rembold,Microsystem Technology and Microrobotics,Springer-Verlag Berlin Heidelberg ,1997

Bos Chairman

Course Code : 141CC9115	Course Title: COMPUTATIONAL FLUID DYNAMICS	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Familiarize the governing equations for fluid flow and the finite difference formulations.
2. Enable the students to calculate the conduction heat transfer using finite difference method.
3. Enable the students to calculate the convection heat transfer using finite difference method.
4. Introduce the procedures for solving viscous fluid flow.
5. Enable the students to understand the concept of turbulence modeling.

UNIT I GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD 9

Continuity equation, momentum equation, energy equation, classification, initial and boundary conditions, finite difference method -central, forward and backward difference, uniform and non-uniform grids, numerical errors.

UNIT II CONDUCTION HEAT TRANSFER 9

Steady one-dimensional conduction, two and three-dimensional steady state problems, transient one-dimensional problem, two-dimensional transient problems

UNIT III CONVECTION HEAT TRANSFER 9

Steady one-dimensional and two-dimensional convection – diffusion, unsteady one-dimensional convection – diffusion, unsteady two-dimensional convection – diffusion.

UNIT IV INCOMPRESSIBLE FLUID FLOW 9

Governing equations, stream function – vorticity method, determination of pressure for viscous flow, SIMPLE procedure of Patankar and Spalding, computation of boundary layer flow.

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UNIT V TURBULENCE MODELS 9

Algebraic models – one equation model, K – Ɛ models, standard and high and low Reynolds number models, prediction of fluid flow and heat transfer using standard codes.

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the discretization of governing equations using finite difference method.

CO2: Calculate the conduction heat transfer using finite difference method.

CO3: Calculate the convection heat transfer using finite difference method.

CO4: Solve incompressible viscous flow problems using vorticity method and SIMPLE algorithm.

CO5: Calculate the fluid flow and heat transfer properties using turbulence modeling.

Text Books

1. Anderson D.A., Tannehil J.C, Pletcher R.H, Computational Fluid Mechanics & Heat Transfer, Hemisphere Publishing Corporation, New York, 2004.
2. John D. Anderson, Computational Fluid Dynamics: The Basics with Applications, First Edition, McGraw-Hill Education, 2012

References

1. Murlidhar.K., Sunderrajan.T, Computational Fluid Mechanics and Heat Transfer, Narosa Publishing House, 2008.
2. Klaus A. Hofmann, Steve T. Chiang, Computational Fluid Dynamics, Fourth Edition, Engineering Education System, 2000.

Bos Chairman

Course Code : 141CC9116	Course Title: MODELING OF DYNAMIC SYSTEMS	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Develop simple mathematical models of the physical systems.
2. Calculate the feedback characteristics of control systems and explain different system components.
3. Analyze the time response of the systems and explain stability in the time domain.
4. Analyze the frequency response of the systems and explain stability in the frequency domain.
5. Explain the design consideration of compensators and solve state equations of systems.

UNIT I MATHEMATICAL MODELS OF PHYSICAL SYSTEMS 9

Introduction to control systems, differential equations of physical systems, dynamics of robotic mechanism, transfer functions, block diagram algebra, signal flow graphs.

UNIT II FEEDBACK CHARACTERISTICS OF CONTROL SYSTEMS AND COMPONENTS 9

Feed back and non feedback systems, reduction of parameter variations, control over system dynamics, control of the effects of disturbance signals, linearizing effect, regenerative feedback, Linear approximation on non-linear systems, stepper motors, hydraulic systems, pneumatic systems.

UNIT III TIME RESPONSE ANALYSIS AND STABILITY IN TIME DOMAIN 9

Standard test signals, time response of first-order systems, time response of second-order systems, steady-state errors and error constraints, effect of adding a zero to a system, design specifications of second-order systems, design considerations for higher-order system, performance indices, robotic control systems, state variable analysis, approximation of higher-order systems by lower order systems, concept of stability, necessary conditions, Routh stability criterion, relative stability analysis.

UNIT IV FREQUENCY RESPONSE ANALYSIS AND STABILITY IN FREQUENCY DOMAIN 9

Bos Chairman

Correlation between time and frequency response, polar plots, bode plots, all-pass and minimum-phase systems, experimental determination of transfer functions, log-magnitude versus phase plots, Nyquist stability criterion, assessment of relative stability, closed loop frequency response, sensitivity analysis.

UNIT V INTRODUCTION TO DESIGN AND STATE VARIABLE ANALYSIS 9

Preliminary considerations, realization of basic compensators, cascade compensation in time domain and frequency domain, feedback compensation, robust control system design. Concepts of state, state variables and state model, state models for linear-continuous-time systems, state variables and linear discrete-time systems, solutions of state equations, concepts of controllability and observability, pole placement by state feedback.

Course Outcomes

At the end of the course students will be able to:

CO1: Develop simple mathematical models using differential equations of the given robotic physical systems.

CO2: Calculate the feedback characteristics of a given control systems such as system dynamics, disturbance signals, linearizing effect, regenerative feedback and explain different systems components.

CO3: Analyze the time response in first order and second order systems and explain the stability in the time domain.

CO4: Analyze the frequency response in first order and second order systems and explain the stability in the frequency domain.

CO5: Explain the design consideration of basic compensators and solve state equations for linear continuous time systems or linear discrete time systems.

Text Books

1. Nagrath I J, and Gopal M, "Control Systems Engineering"' New Age International Publishers, Sixth edition, 2017
2. Gopal M, "Control Systems-Principles and design"' Tata McGraw Hill Co. ltd., Fourth Edition, 2012

References

1. Ogata K, "Modern Control Engineering"' Pearson/Prentice hall of India Pvt. Ltd., New Delhi, 2010.
2. Norman S Nise, " Control System Engineering"' John Wiley & Sons Inc., 2015
3. Sergey Edward Lyshevski, "Control Systems-Theory with Engineering Applications"' Springer-Verlag, New York Inc., 2002

Bos Chairman

Course Code: 141CC9117	Course Title: DESIGN AND ANALYSIS OF THERMAL SYSTEMS	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Understand the design principles of workable and optimal systems.
2. Solve the mathematical modeling of thermal systems.
3. Solve the modeling of thermal equipments.
4. Apply optimization techniques to solve the objective function of the thermal system.
5. Solve the dynamic behaviour of thermal system.

UNIT I INTRODUCTION 9

Design Principles, workable systems, optimal systems, matching of system components, economic analysis , depreciation, gradient present worth factor.

UNIT II MATHEMATICAL MODELING 9

Equation fitting, nomography, empirical equation, regression analysis, different modes of mathematical models, selection, computer programmes for models.

UNIT III MODELLING THERMAL EQUIPMENTS 9

Modelling heat exchangers, evaporators, condensers, absorption and rectification columns, compressor, pumps, simulation studies, information flow diagram, solution procedures.

UNIT IV SYSTEMS OPTIMIZATION 9

OBJECTIVES function formulation, constraint equations, mathematical formulation, Calculas method, dynamic programming, geometric programming, linear programming methods, solution procedures

UNIT V DYNAMIC BEHAVIOUR OF THERMAL SYSTEM 9

Steady state simulation, Laplace transformation, feedback control loops, stability analysis, non-linearties.

Bos Chairman

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the design principles of workable and optimal systems

CO2: Solve the mathematical modeling of thermal systems by using empirical equation and regression analysis.

CO3: Solve the modeling of thermal equipments by simulation studies.

CO4: Apply optimization techniques to solve the objective function of the thermal system

CO5: Solve the dynamic behavior of thermal system by simulation.

Text Books

1. Stoecker W F, "Design of Thermal Systems"' McGraw Hill, 2011.
2. Kapur J N, "Mathematical Modelling"' 2nd Edition, New Age International Pvt Ltd Publishers, 2015.

References

1. Fanger P O, "Thermal Comport" McGraw Hill, USA 1973.
2. McQuiston F C and Parker T D, " Heating, Ventilating and Air conditioning, Analysis and design"' 6th Edition, John Wiley and Sons Pvt Ltd , 2011.

Bos Chairman

Course Code : 141CC9118	Course Title: ENTERPRISE RESOURCE PLANNING	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Gain knowledge on planning an enterprise
2. Apply technology related developments
3. Apply ERP implementation strategies and relate organizational issues
4. Apply ERP on the net

UNIT I ENTERPRISE RESOURCE PLANNING **10**

Principle – ERP framework – Business Blue Print – Business Engineering vs Business process Re-Engineering – Tools – Languages – Value chain – Supply and Demand chain – Extended supply chain management – Dynamic Models –Process Models

UNIT II TECHNOLOGY AND ARCHITECTURE **10**

Client/Server architecture – Technology choices – Internet direction – Evaluation framework – CRM – CRM pricing – chain safety – Evaluation framework.

UNIT III ERP SYSTEM PACKAGES **10**

SAP - People soft, Baan and Oracle – Comparison – Integration of different ERP applications – ERP as sales force automation – Integration of ERP and Internet – ERP Implementation strategies – Organizational and social issues.

UNIT IV ORACLE **7**

Overview – Architecture – AIM: – applications – Oracle SCM. SAP: Overview – Architecture – applications -Before and after Y2k – critical issues – Training on various modules of IBCS ERP Package-Oracle ERP and MAXIMO, including ERP on the NET

UNIT V ERP PROCUREMENT ISSUES **8**

Market Trends – Outsourcing ERP – Economics – Hidden Cost Issues – ROI – Analysis of cases from five Indian Companies

Bos Chairman

Course Outcomes

At the end of the course students will be able to:

CO1: Apply the knowledge on planning an enterprise

CO2: Apply technology related developments

CO3: Apply ERP implementation strategies and relate organizational issues

CO4: Apply ERP on the net

Text Books

1. Sadagopan. S, ERP-A Managerial Perspective, Tata McGraw Hill, 2009.
2. Vinod Kumar Crag and N.K.Venkitakrishnan, Enterprise Resource Planning – Concepts and Practice, Prentice Hall of India, 2009.

References

1. ERPWARE, ERP Implementation Framework, Garg&Venkitakrishnan, Prentice Hall, 2001.
2. Thomas E Vollmann and BeryWhybark, Manufacturing and Control Systems, Galgothia Publications, 2003.
3. Jose Antonio Fernandez, The SAP R/3 Handbook, Tata McGraw Hill, 2003.

Bos Chairman

Course Code : 141CC9119	Course Title: FLEXIBLE COMPETITIVE MANUFACTURING SYSTEM	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- CNC Machines and Robotics

Course Objectives

The course is intended to:

1. Explain the manufacturing techniques in competitive environment.
2. Explain the concepts of group technology in FMS.
3. Explain the Flexible manufacturing systems and its techniques.
4. Explain the software and database related to FMS.
5. Explain the JUST IN TIME concept.

UNIT I MANUFACTURING IN A COMPETITIVE ENVIRONMENT 9

Automation of manufacturing process - Numerical control - Adaptive control - material handling and movement - Industrial robots - Sensor technology - flexible, fixturing - Design for assembly, disassembly and service.

UNIT II GROUP TECHNOLOGY 9

Part families - classification and coding - Production flow analysis - Machine cell design - Benefits.

UNIT III FLEXIBLE MANUFACTURING SYSTEMS 9

Introduction - Components of FMS - Application workstations - Computer control and functions - Planning, scheduling and control of FMS - Scheduling - Knowledge based scheduling - Hierarchy of computer control - Supervisory computer.

UNIT IV COMPUTER SOFTWARE, SIMULATION AND DATABASE OF FMS 9

System issues - Types of software - specification and selection - Trends - Application of simulation - software - Manufacturing data systems - data flow - CAD/CAM considerations - Planning FMS database.

Bos Chairman

UNIT V JUST IN TIME 9

Characteristics of JIT - Pull method - quality -small lot sizes - work station loads - close supplier ties - flexible work force - line flow strategy - preventive maintenance - Karban system - strategic implications - implementation issues - MRD JIT - Lean manufacture.

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the manufacturing techniques in competitive environment for feature industries.

CO2: Explain the concepts of group technology in FMS for machine cell design.

CO3: Explain the Flexible manufacturing systems and its techniques for feature industries.

CO4: Explain the software and database related to FMS for manufacturing data systems.

CO5: Explain the JUST IN TIME concept for effective manufacturing.

Text Books

1. Groover M.P., "Automation, Production Systems and Computer Integrated Manufacturing ", Prentice-Hall of India Pvt. Ltd., New Delhi, 2009.
2. Jha, N.K. " Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991

References

1. Kalpakjian, " Manufacturing Engineering and Technology ",Prentice Hall; 6 edition , 2009
2. Taiichi Ohno, Toyota, " Production System Beyond Large-Scale production", Productivity Press (India) Pvt. Ltd., 1992

Web References

- https://nptel.ac.in/courses/112107143/36
- https://nptel.ac.in/courses/112104228/31

Bos Chairman

Course Code : 141CC9120	Course Title: OPTIMIZATION TECHNIQUES IN DESIGN	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Understand the Principles of optimization and its needs
2. Learn various conventional optimization techniques
3. Solve multivariable problems
4. Solve problems using Unconventional optimization techniques
5. Apply optimization to design of machine elements

UNIT I INTRODUCTION 5

General Characteristics of mechanical elements, adequate and optimum design, principles of optimization, formulation of OBJECTIVES function, design constraints – Classification of optimization problem.

UNIT II UNCONSTRAINED OPTIMIZATION 8

Single variable and multivariable optimization, Techniques of unconstrained minimization – Golden section, pattern and gradient search methods – Interpolation methods.

UNIT III CONSTRAINED OPTIMIZATION 12

Optimization with equality and inequality constraints - Indirect methods using penalty functions, Lagrange multipliers; Geometric programming- Constrained, mixed inequality and unconstrained minimization; Genetic algorithms.

UNIT IV STATIC APPLICATIONS 10

Structural applications – Design of simple truss members. Design applications – Design of simple axial, transverse loaded members for minimum cost, maximum weight – Design of shafts and torsionally loaded members – Design of springs.

UNIT V DYNAMIC APPLICATIONS 10

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

Bos Chairman

Course Outcomes

At the end of the course students will be able to:

CO1: Apply the principles of optimization and its needs.

CO2: Apply various conventional optimization techniques.

CO3: Solve multivariable problems.

CO4: Solve problems using unconventional optimization techniques.

CO5: Apply optimization to design of machine elements.

Text Books

1. SingiresuS.Rao. "Engineering Optimization Theory and Practice", Wiley; 4 edition 20, 2009.
2. Johnson Ray, C., "Optimum design of mechanical elements", Wiley, John & Sons, 2000.

References

1. Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India Pvt. 1995
2. Goldberg, D.E., "Genetic algorithms in search, optimization and machine", Barnen, Addison-Wesley, New York, 1989.
3. Saravanan.R, "Manufacturing optimization through intelligent techniques", Taylor and Francis Publications, CRC Press, 2006.

Bos Chairman

Course Code :141CC9121	Course Title: DESIGN OF MATERIAL HANDLING EQUIPMENT	
Core/Elective: Elective	**L : T : P : C**	3:0:0:3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Select suitable hoisting equipment.
2. Design the load handling equipments and brakes.
3. Select a suitable surface and overhead transportation equipments.
4. Design the elevating equipments.
5. Design the conveying equipments.

UNIT I FLEXIBLE HOISTING APPLIANCES 9

Type, selection and applications of material handling equipments, choice of material handling equipment – hoisting equipment – components and theory of hoisting equipment – chain and ropes – selection of ropes, pulleys, pulley systems, sprockets and drums.

UNIT II LOAD HANDLING EQUIPMENTS AND BRAKES 9

Forged standard hooks – forged Ramshorn hooks – solid triangular eye hooks – crane grabs, electric lifting magnetic – grabbing attachments for loose materials. arresting gear – brakes: shoe, band and cone types – elements of shoe brakes – thermal calculation in shoe brakes.

UNIT III SURFACE AND OVERHEAD TRANSPORTATION EQUIPMENTS 9

Hand operated trucks – powered trucks – tractors – electronically controlled tractors - hand truck on rails – industrial railroad equipments: locomotives - winches – capstans – turntables – monorail conveyors – pipe rail systems – flat bar monorails. Rail traveling mechanism, cantilever and monorail cranes, cogwheel drive, monocable tramways-reversible tramways.

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UNIT IV ELEVATING EQUIPMENTS 9

Continuous-motion vertical conveyors – reciprocating-motion vertical conveyors – stackers – work levelers and tail gates – industrial lifts – passenger lifts – freight elevators – mast type elevators – vertical skip hoist elevators, bucket elevators: design, loading and bucket arrangements.

UNIT V CONVEYING EQUIPMENTS 9

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

Course Outcomes

At the end of the course students will be able to:

CO1: Select a suitable material handling equipments for hoisting application.
CO2: Design the load handling equipments and brakes for given applications.
CO3: Select a suitable surface and overhead transportation equipments for given applications.
CO4: Design the elevating equipments for given application.
CO5: Design the conveying equipments for given application.

Text Books

1. Rudenko. N., Materials Handling Equipment – MIR Publishers, 1970
2. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981

References

1. Spivakovsky. A.O and Dyachkov. V.K., Conveying Machines, Volume I and II, MIR Publishers, 1985
2. Lingaiah. K. and Narayana Iyengar, Machine Design Data Hand Book, Vol. 1 & 2, Suma Publishers, 1986
3. Chowdary.R.B and Tagore.G.R.N.– Materials Handling Equipment –Khanna Publishers, 1996

Bos Chairman

Course Code : 141CC9122	Course Title: DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS	
Core/Elective: Elective	**L : T : P : C**	3:0:0:3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Explain the fluid power systems.
2. Explain the construction and working of hydraulic components.
3. Develop a hydraulic circuit.
4. Explain construction and working of pneumatic components.
5. Develop a pneumatic circuit.

UNIT I FLUID POWER SYSTEM AND FUNDAMENTALS 6

Introduction to Fluid power - Types of fluid power systems - Hydraulic system components -Pneumatic system components - Application of Pascal's Law in hydraulics-Advantages of fluid power system -Applications of Fluid power system -Properties of hydraulic fluids - Types of fluids.

UNIT II HYDRAULIC SYSTEM AND COMPONENTS 9

Pumping theory - Pump classification - Construction and working of gear pumps, Vane pumps, Piston pumps - Construction and working of linear actuators - Special cylinder - Rotary actuator – Construction and operation of direction control valves (DCV), Pressure control valve, Flow control valve – Electrical control solenoid valves, relays, Electro hydraulic servo valves. Construction and operation of accumulators, Intensifiers.

UNIT III HYDRAULIC CIRCUITS 12

Hydraulic symbols - Hydraulic circuits for linear actuators - Hydraulic circuits using different actuating devices - Speed control circuits - Sequencing circuit - Synchronizing circuit - Regenerative circuit - Accumulator circuit – Application of intensifier - Hydraulic circuit for Milling operation, Grinding Machine - forklift, earth mover circuits -Hydraulic braking in Automobile.

UNIT IV PNEUMATIC SYSTEM AND COMPONENTS 9

Properties of air – Compressor - Types of compressor - Construction and operation of air filter, air regulator, air lubricator - Pneumatic linear actuator - Rotary actuator - Constriction and working of pneumatic direction control valve – Flow control valve - Pneumatic symbols

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UNIT V PNEUMATIC CIRCUITS 9

Pneumatic circuits for single acting cylinder, Double acting cylinder - Pneumatic circuits using manual, mechanical, electrical actuating devices - Cascade method for sequencing: two and three cylinders - mapping methods - step counter method- - compound circuit design - combination circuit design. Hydro-Pneumatic circuit - Material handling system circuit - Multiple operation Machining.

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the fluid power systems with fluid properties and applications.
CO2: Explain the construction and working of hydraulic system components.
CO3: Develop a hydraulic circuit for milling, grinding, forklift, earth movers and automobile braking application.
CO4: Explain the construction and working of pneumatic system components.
CO5: Develop a pneumatic circuit for material handling and machining application.

Text Books

1. Esposito Anthony, "Fluid Power with Applications", Pearson Education Inc., New York, 2008.
2. Bolton. W., "Pneumatic and Hydraulic Systems ", Butterworth –Heinemann, 1997.

References

1. Andrew Parr, "Hydraulic and Pneumatic" (HB), Jaico Publishing House, 2004.
2. Majumdar, S.R., Oil Hydraulic Systems, Principles and Maintenance, Tata MGraw Hill Prentice Hall, 2001.
3. Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata McGraw-Hill, New Delhi, 2006

Web References

- http://www.nptel.ac.in/courses/112106175/
- http://nptel.ac.in/courses/112105046/

Bos Chairman

Course Code : 141CC9123	Course Title: PRODUCT DATA MANAGEMENT	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Learn about the components of a typical PDM
2. Develop the simple projects in life cycle of a product
3. Study about the Data Management Systems for FEA data

UNIT I INTRODUCTION 3

Introduction to PDM-present market constraints-need for collaboration - internet and developments in server-client computing.

UNIT II COMPONENTS OF PDM 9

Components of a typical PDM setup-hardware and software-document management-creation and viewing of documents-creating parts-versions and version control of parts and documents-case studies.

UNIT III CONFIGURATION MANAGEMENT 5

Base lines-product structure-configuration management-case studies.

UNIT IV PROJECTS AND ROLES 12

Creation of projects and roles-life cycle of a product- life cycle management-automating information flow- work flows- creation of work flow templates -life cycle-work flow integration-case studies.

UNIT V CHANGE MANAGEMENT 6

Change issue- change request- change investigation- change proposal - change activity – case studies.

UNIT VI GENERIC PRODUCTS AND VARIANTS 10

Data Management Systems for FEA data - Product configurator - comparison between sales configuration and product configurator-generic product modeling in configuration modeler-use of order generator for variant creation-registering of variants in product register-case studies.

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Course Outcomes

At the end of the course students will be able to:

CO1: Explain the components of a typical PDM.

CO2: Develop the simple projects in life cycle of a product.

CO3: Apply Data Management Systems in FEA data.

Text Books

1. Kevin Otto, Kristin Wood, "Product Design", Pearson, 2007.
2. David Bed worth. Mark Henderson & Phillip Wolfe. "Computer Integrated Design and Manufacturing ". McGraw Hill Inc...2001.

References

1. Terry Quatrain. "Visual Modeling with Rational Rose and UML ". Addison Wesley...1998.
2. Wind-Chill RUNIT V0 Reference Manuals...2000.

Bos Chairman

Course Code :141CC9124	Course Title: ENGINEERING FRACTURE MECHANICS	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Applied material Engineering

Course Objectives

The course is intended to:

1. Drive the field equations for stress intensity factor
2. Drive and apply the critical energy release rate equation to solve the fracture problem
3. Drive the equations for critical stress intensity factor for cases like, wedge loads, elliptical and semielliptical cracks in plates
4. Explain the concept of J-integral and CTOD
5. Explain the testing methods to determine the critical values for the parameters such as stress intensity factor(KIC),J-Integral (JIC),energy release rate(GIc and GIIC) and crack tip opening displacement (CTODC).

UNIT I ELEMENTS OF SOLID MECHANICS 9

Brittle and Ductile Fracture , Modes of Fracture Failure ,The geometry of stress and strain, elastic deformation, Plastic and elasto-Plastic deformation - Limit analysis– Airy's function – Field equation for stress intensity factor.

UNIT II ENERGY RELEASE RATE 9

Surface Energy, Griffith's Analysis, Energy Release Rate, Energy Release Rate of DCB Specimen, Stable and Unstable Crack Growth, R-curve for Brittle Cracks, Thin Plate vs Thick Plate, Critical Energy Release Rate

UNIT III STRESS INTENSITY FACTOR 9

Linear elastic fracture mechanics, Westergaard's approach, Critical stress intensity factor, SIF of more complex cases- Wedge loads on cracked surfaces, Crack in a plate of finite dimensions, Elliptical crack, Semi-elliptical cracks, The relation between G_I and K_I.

UNIT IV ANELASTIC DEFORMATION AT THE CRACK TIP 9

Plastic Zone Shape for Plane Stress, Plastic Zone Shape for Plane Strain, Approximate Approach, The Irwin Plastic Zone Correction, Plastic Zone Size through the Dugdale

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Approach, Effect of Plate Thickness, LEFM, elastic-plastic fracture mechanics,J-Integral, J Integral for a double cantilever beam (DCB) specimen,crack tip opening displacement (CTOD), relationship between CTOD, K_I and G_I for small scale yielding.

UNIT V TEST METHODS 9

k_{1c}-test technique, variou test specimens, clip gauge, load-displacement test, measuring the crack length, test methods to determine J_{Ic}, test methods to determine G_{Ic} and G_{IIC}, determination of critical CTOD

Course Outcomes

At the end of the course students will be able to:

CO1: Drive the field equations for stress intensity factor.

CO2: Drive and apply the critical energy release rate equation to solve the fracture problem.

CO3: Drive the equations for critical stress intensity factor for cases like, wedge loads, elliptical and semielliptical cracks in plates.

CO4: Explain the concept of J-integral and CTOD.

CO5: Explain the testing methods to determine the critical values for the parameters such as stress intensity factor(K_{IC}),J-Integral(J_{IC}),energy release rate(G_{Ic} and G_{IIC}) and crack tip opening displacement ($CTOD_C$).

Text Books

1. Preshant Kumar, "Elements of Fracture Mechanics", McGraw Hill Education (India) Private Limited, 2014.
2. TribikramKundu, "Fundamentals of Fracture Mechanics" CRC press,2012

References

1. T. L. Anderson,"Fracture Mechanics: Fundamentals and Applications", Second Edition, CRC press,1995.
2. R. J. Sanford ,Principles of Fracture Mechanics, Prentice Hall, 2003
3. David Broek, "Elementary Engineering Fracture Mechanics ",Springer Science & Business Media , 1984.
4. KareHellan, "Introduction of Fracture Mechanics", McGraw-Hill Book Company, 1985.
5. John M.Barson and StanelyT.Rolfe Fatigue and fracture control in structures Prentice hall Inc. Englewood cliffs. 1987

Bos Chairman

Course Code : 141CC9125	Course Title: COMBUSTION AND EMISSION IN ENGINES	
Core/Elective: Elective	**L : T : P : C**	3:0:0:3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Explain the concepts and chemistry of combustion
2. Explain the combustion processes in spark ignition engine
3. Explain the combustion processes in compression ignition engine
4. Explain the combustion processes in gas turbines
5. Explain the concepts of emission and its effect on environment

UNIT I COMBUSTION PRINCIPLES **8**

Combustion – Combustion equations, heat of combustion - Theoretical flame temperature – chemical equilibrium and dissociation - Theories of Combustion - Pre-flame reactions - Reaction rates - Laminar and Turbulent Flame Propagation in Engines.

UNIT II COMBUSTION IN SPARK IGNITION ENGINE **12**

Initiation of combustion, stages of combustion, normal and abnormal combustion, knocking combustion, pre-ignition, knock and engine variables, features and design consideration of combustion chambers. Flame structure and speed, Cycle by cycle variations, Lean burn combustion, stratified charge combustion systems. Heat release correlations. After treatment devices for SI engines.

UNIT III COMBUSTION IN COMPRESSION IGNITION ENGINE **10**

Stages of combustion, vaporization of fuel droplets and spray formation, air motion, swirl measurement, knock and engine variables, features and design considerations of combustion chambers, delay period correlations, heat release correlations, Influence of the injection system on combustion. Direct and indirect injection systems.

UNIT IV COMBUSTION IN GAS TURBINES **5**

Flame stability, re-circulation zone and requirements - Combustion chamber configuration, materials.

Bos Chairman

UNIT V EMISSIONS **10**

Main pollutants in engines, Kinetics of NO formation, NOx formation in SI and CI engines. Unburned hydrocarbons, sources, formation in SI and CI engines, Soot formation and oxidation, Particulates in diesel engines, Emission control measures for SI and CI engines, Effect of emissions on Environment and human beings.

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the concepts and chemistry of combustion
CO2: Explain the combustion processes in spark ignition engine
CO3: Explain the combustion processes in compression ignition engine
CO4: Explain the combustion processes in gas turbines
CO5: Explain the concepts of emission and its effect on environment

Text Books

1. Ramalingam, K.K., Internal Combustion Engines, Scitech Publications (India) Pvt. Ltd., 2009
2. Ganesan, V, Internal Combustion Engines, Tata McGraw Hill Book Co., 2002

References

1. Mathur,M.L., and Sharma,R.P., A Course in Internal Combustion Engines, Dhanpat Rai Publications Pvt. New Delhi-2, 1998
2. Obert,E.F., Internal Combustion Engine and Air Pollution, International Text Book Publishers, 1968

Bos Chairman

Course Code : 141CC9126	**Course Title:** ADVANCED TOOL DESIGN	
Core/Elective: Elective	**L : T : P : C**	3:0:0:3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Explain the design procedures used in tool design.
2. Select a suitable tooling material and heat treatment process.
3. Design a drill jig.
4. Design fixtures for the press tools.
5. Design fixtures for the numerically controlled machine tools.

UNIT I TOOL-DESIGN METHODS **5**

Introduction – The Design Procedure – Statement of the problem – The Needs Analysis – Research and Ideation – Tentative Design Solutions – The Finished Design – Drafting and Design Techniques in Tooling drawings – Screws and Dowels – Hole location – Jig-boring practice – Installation of Drill Bushings – Punch and Die Manufacture – Electro-discharge machining – Electro-discharge machining for cavity.

UNIT II TOOLING MATERIALS AND HEAT TREATMENT **12**

Introduction – Properties of Materials – Ferrous Tooling Materials – Tool steels – Cast Iron – Mild, or low-carbon Steel – Nonmetallic Tooling Materials – Nonferrous Tooling Materials – Metal cutting Tools– Single-point cutting tools – Milling cutters – Drills and Drilling – Reamer classification – Taps – Tap classification- the selection of carbide cutting tools – Determining the insert thickness for carbide tools

UNIT III DESIGN OF DRILL JIGS **12**

Introduction – Fixed Gages – Gage Tolerances – The 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 – Drill jigs and modern manufacturing

UNIT IV DESIGN OF FIXTURES AND DIES **8**

Bos Chairman

Introduction – Fixtures and economics – Types of Fixtures – Vise Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures – Lathe Fixtures – Grinding Fixtures – Types of Die construction – Die-design fundamentals – Blanking and Piercing die construction – Pilots – Strippers and pressure pads-Presswork materials – Strip layout – Short-run tooling for Piercing – Bending dies – Forming dies – Drawing operations.

UNIT V TOOL DESIGN FOR NUMERICALLY CONTROLLED MACHINE TOOLS 8

Introduction – The need for numerical control – A basic explanation of numeric control – Numerical control systems in use today – Fixture design for numerically controlled machine tools – Cutting tools for numerical control – Tool holding methods for numerical control – Automatic tool changers and tool positioners – Tool presetting – Introduction – General explanation of the Brown and sharp machine – tooling for Automatic screw machines

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the design procedures used in design of press tools applied in sheet metal forming.

CO2: Select a suitable material and heat treatment process to achieve the desired strength in press tools.

CO3: Design a drill jig based on the given specification.

CO4: Design fixtures for the press tools based on the given specification.

CO5: Design fixtures for the numerically controlled machine tools based on the given specification.

Text Books

1. Mehta,N.K., "Machine Tool design and Numerical Control", Tata McGraw Hill,2017.
2. Cyrll Donaldson, George H.LeCain, V.C. Goold, "Tool Design", Tata McGraw Hill Publishing, 2012

References

1. Luqman M, "Sheet Metal Press Tools Design Making ", CBS publishing, 2015
2. Prakash Hiralal Joshi, "Machine tools handbook: design and operation ", Tata McGraw Hill Publishing Company Ltd., 2007

Bos Chairman

Course Code : 141CC9127	Course Title: MODELING AND ANALYSIS OF MANUFACTURING SYSTEMS	
Core/Elective: Elective	**L : T : P : C**	3:0:0:3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Understand the fundamentals of automation in material handling
2. Understand the types and principles of manufacturing systems
3. Understand the concepts and components of manufacturing supporting system
4. Explain key management interfaces and activities
5. Explain the various optimized production techniques

UNIT I MANUFACTURING SYSTEMS AND MODELS 9

Types and principles of manufacturing systems, types and uses of manufacturing models, physical models, mathematical models, model use, model building.

UNIT II MATERIAL FLOW SYSTEMS 9

Assembly lines - Reliable serial systems, approaches to line balancing, sequencing mixed models. Transfer lines and general serial systems-paced lines without buffers, unpaced lines. Shop scheduling with many products. Group technology-assigning machines to groups, assigning parts to machines.

UNIT III SUPPORTING COMPONENTS 9

Machine setup and operation sequencing - integrated assignment and sequencing. Material handling systems - conveyor analysis, AGV systems. Warehousing - storage and retrieval systems, order picking.

UNIT IV GENERIC MODELING APPROACHES 9

Analytical queuing models, a single workstation, open networks, closed networks. Empirical simulation models - even models, process models, simulation system, example manufacturing system.

UNIT V SYNCHRONIZATION MANUFACTURING 9

Synchronization Vs Optimization, defining the structure, identifying the constraint, exploitation, buffer management.

Bos Chairman

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the principles of manufacturing systems models and its types.
CO2: Choose an appropriate selection of material flow system.
CO3: Select appropriate material handling equipment for supporting components.
CO4: Explain the various Generic Modeling Approaches in the manufacturing system.
CO5: Explain the process of Synchronization Manufacturing.

Text Books

1. Ronald G Askin, "Modeling and Analysis of Manufacturing Systems", John Wiley and Sons, Inc, 1993
2. Brandimarte. P, Villa. A, "Modeling Manufacturing Systems" Springer Verlag, Berlin, 1999.

References

1. Mengchu Zhou, "Modeling, Simulation, and Control of Flexible Manufacturing Ststems: A Petri Net Approach",Worls Scientific Publishing Company Pvt Ltd. 2000
2. Jean Marie Proth and Xiaolan Xie, "Petri Nets: A Tool for Design and Management of Manufacturing Systems" John Wiley and Sons, New York, 1996

Web References

- http://nptel.ac.in
- https://mit.edu/courses/mechanical-engineering

Bos Chairman

Course Code : 141CC9128	Course Title: METROLOGY AND NON DESTRUCTIVE TESTING	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Explain the purpose of mechanical measuring machines
2. Explain the purpose and need for statistical quality control
3. Explain the process of liquid penetrant and magnetic particle testing
4. Explain the radiographic technique
5. Explain the Ultrasonic and Acoustic Emission method

UNIT I MEASURING MACHINES 9

Tool Maker's microscope - Co-ordinate measuring machines - Universal measuring machine - Laser viewers for production profile checks - Image shearing microscope - Use of computers - Machine vision technology - Microprocessors in metrology

UNIT II STATISTICAL QUALITY CONTROL 9

Data presentation - Statistical measures and tools - Process capability - Confidence and tolerance limits Control charts for variables and for fraction defectives - Theory of probability - Sampling - ABC standard - Reliability and life testing.

UNIT III LIQUID PENETRANT AND MAGNETIC PARTICLE TESTS 9

Characteristics of liquid penetrants - different washable systems - Developers - applications - Methods of production of magnetic fields - Principles of operation of magnetic particle test - Applications - Advantages and limitations.

UNIT IV RADIOGRAPHY 9

Sources of ray-x-ray production - properties of d and x rays - film characteristics - exposure charts - contrasts - operational characteristics of x ray equipment - applications.

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UNIT V ULTRASONIC AND ACOUSTIC EMISSION TECHNIQUES 9

Production of ultrasonic waves - different types of waves - general characteristics of waves - pulse echo method - A, B, C scans - Principles of acoustic emission techniques - Advantages and limitations - Instrumentation - applications.

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the critical engineering parameters measured by the measuring instruments to describe the condition of the working machinery or a part.

CO2: Explain the purpose and need for statistical quality control tools , techniques to ensure the quality in the product to meet the design specification

CO3: Explain the process of liquid penetrant and magnetic particle testing to identify the surface flaws in all porous materials

CO4: Explain the radiographic technique to verify the internal structure and integrity of the specimen utilizing either X-rays or gamma rays and to identify the internal defects.

CO5: Explain the Ultrasonic and Acoustic Emission method of non destructive testing using different scan techniques to identify the defect in the product manufactured.

Text Books

1. Jain, R.K. " Engineering Metrology ", Khanna Publishers, 2009, ISBN: 978-81-7409-153-X.
2. American Society for Metals, " Metals Hand Book ", Vol.II, 1988

References

1. Progress in Acoustic Emission, " Proceedings of 10th International Acoustic Emission Symposium ", Japanese Society for NDI, 1990.
2. Barry Hull and Vernon John, " Non Destructive Testing ", MacMillan, 1988.

Web References

- https://www.ndt.net/publicat/books/books.htm
- https://www.sciencedirect.com/science/article/pii/B9780750671231500284

Bos Chairman

Course Code : 141CC9129	Course Title: DATA COMMUNICATION IN CAD / CAM	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Explain the basic logical operations used in digital computer and microprocessors.
2. Explain the tools used in construction of compiler.
3. Explain the protocols to be adopted in data communication.
4. Explain the techniques used in managing remote systems in network.
5. Explain the protocols to be adopted in communication over internet.

UNIT I DIGITAL COMPUTERS & MICRO PROCESSORS 9

Block diagram - register transfer language - arithmetic, logic and shift micro operations - instruction code - training and control instruction cycle - I/O and interrupt design of basic computer, Machine language - assembly language - assembler.

Registers ALU and Bus Systems - timing and control signals - machine cycle and timing diagram - functional block diagrams of 80 x 86 and modes of operation. Features of Pentium Processors

UNIT II OPERATING SYSTEM & ENVIRONMENTS 9

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

UNIT III COMMUNICATION MODEL 9

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

Bos Chairman

UNIT IV COMPUTER NETWORKS 9

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

UNIT V INTERNET 9

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

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the basic logical operations used in digital computer and microprocessors.
CO2: Explain the tools used in construction of compiler.
CO3: Explain the protocols to be adopted in data communication.
CO4: Explain the techniques used in managing remote systems in network.
CO5: Explain the protocols to be adopted in communication over internet.

Text Books

1. Morris Mano. M., "Computer System Architecture", Prentice Hall of India, 2007.
2. Gaonkar R.S., "Microprocessor Architecture, Programming and Applications of 8085", Penram International, 2013

References

1. Silberschaz, A, Galvin P and Gagne G., "Operating Systems Concepts", Wiley, 2009.

Bos Chairman

Course Code : 141CC9130	Course Title: DESIGN OF AUTOMOTIVE SYSTEMS	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Mechanical Vibrations

Course Objectives

The course is intended to:

1. Explain the layout of automobiles contains sprung and un-sprung mass.
2. Construct the design diagram of clutches.
3. Determine the elements involved in transmission system with proper kinematic linkages.
4. Determine the design parameters spring and steering.
5. Explain braking system with their linkages in Automobiles.

UNIT I INTRODUCTION 9

Fundamentals of designing automobiles-performance of automobiles, general layout of the automobile Design conditions-loading conditions, maximum moments in automobile transmission, forced vibrations of sprung mass with random disturbance, fatigue resistance analysis procedure.

UNIT II CLUTCH 9

Introduction-design diagrams of clutch, calculation of critical parameters of clutches, design calculation of standard elements of friction clutches, torsional vibration dampers, clutch control drives.

UNIT III TRANSMISSION 9

Determining main parameters of transmission, gear shift mechanisms, main gear, differential, differential housings, axle shafts, fear box, auxiliary gear box, transfer case, planetary gears, kinematics of universal joints, design of universal joint and propeller shaft, location determination of universal joint and propeller shaft.

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UNIT IV SUSPENSION AND STEERING SYSTEM 9

Oscillation and smoothness of ride, elastic characteristics of ride, elastic elements of suspension, shock absorbers. Fundamentals of designing and calculating steering control linkage, steering gears, hydraulic booster.

UNIT V BRAKES 9

Pressure distribution along shoe length, determining braking torque, design of drum and disk brakes, fundamentals of designing brake force regulators, antilocking system.

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the layout with loading conditions, vibrations of automobiles contains sprung and un-sprung mass.

CO2: Construct the design diagram of clutches including the critical parameters like friction element materials, control parameters and torsional vibration dampers.

CO3: Determine the elements involved in transmission system like gear shaft, gear box, propeller shaft with proper kinematic linkages.

CO4: Determine the design parameters of helical and leaf spring and mechanical and Power steering with proper gearing ratios.

CO5: Explain braking system with their linkages, developments and sophistication in design and efficiencies assisted with recent technologies like ABS, ESP in Automobiles.

Text Books

1. Lukin P Gasparyants G and Rodionov V, "Automobile Chassis Design and Calculations", Mir,1989
2. Heinz Heisier, "Vehicle and Engine technology"' SAE, New York, 1999

References

1. Reza.N.jazar, " Vehicle Dynamics: Theory and applications"' Springer., 2008
2. Schwaller A E, "Motor Automotive Technology"' Third Edition, Delman Publishers, New York, 2008.

Bos Chairman

Course Code : 141CC9131	Course Title: ADVANCED MECHANISMS DESIGN AND SIMULATION	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Apply the concepts related to basic kinematic chains
2. Apply kinematic analysis to given mechanisms
3. Apply kinematic synthesis to mechanism design
4. Explain kinematic analysis of spatial mechanism

UNIT I INTRODUCTION 5

Review of fundamentals of kinematics – mobility analysis – formation of one D.O.F. multi loop kinematic chains, Network formula – Gross motion concepts.

UNIT II KINEMATIC ANALYSIS 5

Displacement, Velocity and acceleration analysis of simple mechanisms, instant centres kinematic analysis of complex mechanisms, Goodman analysis, auxiliary point method.

UNIT III PATH CURVATURE THEORY 6

Inflection point and inflection circles. Euler – Savary equation, Bobilliers constructions , Hartmann's construction, the cubic of stationary curvature or Burmester's circle point and center point curves for four infinitesimally close positions of the moving plane

UNIT IV SYNTHESIS OF MECHANISMS 15

Type synthesis – Number synthesis – Associated Linkage Concept. Dimensional synthesis – function generation, path generation, motion generation. Graphical methods. Cognate linkages -Coupler curve synthesis, design of six-bar mechanisms. Algebraic methods. Application of instant center in linkage design. Cam Mechanisms – determination of optimum size of Cams

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UNIT V DYNAMICS OF MECHANISMS AND SPATIAL MECHANISMS AND ROBOTICS 14

Static force analysis with friction – Inertia force analysis – combined static and inertia force analysis, shaking force, Kinetostatic analysis. Introduction to force and moment balancing of linkages.

Kinematic Analysis of Spatial RSSR mechanism – Denavit – Hartenberg Parameters. Forward and inverse Kinematics of Robotic Manipulators. Study and use of Mechanism using Simulation Soft-ware packages.

Course Outcomes

At the end of the course students will be able to:

CO1: Apply concepts of kinematic chains to perform mobility analysis of simple and compound mechanisms.

CO2: Perform kinematic analysis to simple planar mechanisms and instant centres method of complex mechanisms.

CO3: Apply path curvature methods for construction of inflection circles and inflection points.

CO4: Explain the different linkage synthesis methods for function generation, path generation and motion generation using graphical methods.

CO5: Explain static and dynamic analysis of linkages and kinematic analysis of serial robotic manipulators.

Text Books

1. Uicker, J.J, Pennock G.R. and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press, NY, 2003
2. Amitabha Ghosh and Asok Kumar Mallik, "Theory of Mechanism and Machines", EWLP, Delhi, 1999.

References

1. Sandor G.N., and Erdman A.G., "Advanced Mechanism Design Analysis and Synthesis", Prentice Hall, 4th edition 2001.
2. Nortron R.L., "Design of Machinery", McGraw Hill, 1999
3. Kenneth J, Waldron, Gary L. Kinzel, "Kinematics, Dynamics and Design of Machinery", John Wiley-sons, 1999.

Bos Chairman

Course Code : 141CC9132	Course Title: TRIBOLOGY IN DESIGN	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Identify the tribological problems in real environment.
2. Understand the how to rectify tribological problems.

UNIT I SURFACES, FRICTION AND WEAR 9

Topography of surfaces – Surfaces features – Experimental Determinations of surface structure – Chemical analysis of surface – surface effects in Tribology – Analysis of surface roughness – measurement of surface roughness. Friction – Mechanism of friction, measuring friction, equations and models of friction – Friction propties of metallic and non metallic materials, friction in extreme conditions. Wear – Types, mechanism, mapping, measurements, wear resistance materials – surface treatment, surface modifications and surface coatings. Computer Simulations of friction, lubrication and wear.

UNIT II LUBRICATION THEORY 9

Lubricants – selection criteria – lubrication regimes – Hydrodynamic, elasto and plasto hydrodynamic lubrication, basic equations, Reynold's equation, energy equation, boundary lubrication, boundary lubricating films and its properties. Hydrostatic lubrication – Gas lubrication

UNIT III DESIGN OF FLUID FILM BEARINGS 9

Dynamic analysis of hydrodynamic bearing performance, trust and journal bearings– full, partial, fixed and pivoted – mass flow rate, friction, power loss, heat and temperature difference, dynamic loads, oil film thickness, stiffness of squeeze film and dynamic co-efficient – hydrostatic bearing design.

UNIT IV INDUSTRIAL COMPONENTS AND SYSTEMS 9

Slider bearings – self acting finite bearings, failure modes, materials rolling element bearings – Types, contact mechanics, bearing internal load distribution, lubrication – Bearing geometry and kinematics, load ratings and life prediction, torque calculation, temperature analysis, endurance testing and failure analysis.

Bos Chairman

UNIT V SPACE AND AUTOMOTIVE TRIBOLOGY 9

Introduction – Mechanism, components, liquid and solid lubricants, accelerated testing and life testing of space mechanism. Principles of Aerospace eccentric bearing test mechanism. Engine Tribology – importance, lubrication regimes, engine bearings, wheel bearings, tire. Mechanics of load transfer – contact area and normal pressure distribution, brakes, effects of service on engine oil properties. Tribology in manufacturing – macro and micro tribology of MEMS materials. Technologies for machinery diagnosis and prognosis.

Course Outcomes

At the end of the course students will be able to:

CO1: Explain about surfaces, friction and wear for materials
CO2: Explain about lubrication theory for materials
CO3: Design of fluid film bearings
CO4: Explain about industrial components and systems
CO5: Explain about space and automotive tribology

Text Books

1. Cameron, A. "Basic Lubrication Theory", Ellis Herward Ltd., UK, 1983
2. Hulling, J. (Editor) – " Principles of Tribology", MacMillan, 1984

References

1. Williams, J.A. "Engineering Tribology", Oxford University Press, 1994
2. Bharat Bhushan, "Modern Tribology Handbook" Vol. – I & II.,2001

Web References

- https://www.springer.com/us/book/9781468489767
- https://www.elsevier.com/books/tribology-in-machine-design/stolarski/978-0-08-051967-8

Bos Chairman

Course Code : 141CC9133	Course Title: ADVANCED STRENGTH OF MATERIALS	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Calculate the stresses, strains and elastic constants of structural member subjected to external loads in three dimensional members.
2. Determine the stresses and deflections in beam structures subjected to unsymmetrical loading.
3. Calculate the stresses and strains for thick cylinders and rotating disks such as shafts and cylinders.
4. Determine the torsional stresses for non circular sections.
5. Calculate the stresses in circular and rectangular plates subjected to various types of loads and end conditions of flat plates.

UNIT I STRESSES, STRAINS AND ELASTICITY 8

Stress – Strain relation and General equation of elasticity in cartesian, polar and spherical coordinates-differential equation of equilibrium – compact ability – boundary conditions, representations of three dimensional stress of a tension – generalized Hooke's law – St.Vennant's principle – Plane strain, plane stress – Airy's stress function. hear Centre:Location of shear centre for various sections – shear flow.

UNIT II UNSYMMETRICAL BENDING 10

Stresses and deflection in beams subjected to unsymmetrical loading – Kern of a section. Curved flexural members - circumferential and radial stresses – deflection and radial curved beam with re-strained ends– closed ring subjected to concentrated load and uniform load – chain link and crane hooks.

UNIT III THICK CYLINDERS AND ROTATING DISKS 10

Thick walled cylinder subjected to internal and external pressures – Shrink fit joints – Stresses due to rotation – Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness– allowable speed. – Rotating shafts and cylinders.

UNIT IV TORSION OF NON CIRCULAR SECTIONS 8

Torsion of rectangular cross section – St.Vennant Theory – elastic membrane analogy – Prandtl's stress function – Torsional stresses in hollow thin walled tubes.

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UNIT V STRESSES IN FLAT PLATES 9

Stresses in circular and rectangular plates due to various types of loading and end conditions – Buckling of plates. Theory of contact stresses – methods of computing contact stresses – deflection of bodies in point and line contact – applications.

Course Outcomes

At the end of the course students will be able to:

CO1: Calculate the stresses, strains and elastic constants of structural member subjected to external loads in three dimensional members.
CO2: Determine the stresses and deflections in beam structures subjected to unsymmetrical loading.
CO3: Calculate the stresses and strains for thick cylinders and rotating disks such as shafts and cylinders.
CO4: Determine the torsional stresses for non circular sections.
CO5: Calculate the stresses in circular and rectangular plates subjected to various types of loads and end conditions of flat plates.

Text Books

1. Arthur P.Boresi and Richard J.Schmidt, "Advanced Mechanics of Materials", John, Willey & Sons,Inc., 2003.
2. Robert, D.Cook, Wareen.C.Yound, "Advanced Mechanics of Materials", Macmillon Publishers Company, 1985.
3. Srinath. L.S., Advanced Mechanics of Solids, Tata McGraw Hill Publishing Company Limited, 2003

References

1. Krishna Raju.N.,Gururaja.D.R, Advanced Mechanics of Solids and Structures,Narosa Publishing House, 1997.
2. Jindal. U.C., "Advanced Topics of Strength of materials", Galgotia Publications, First edition, 1997.

Web References

- http://nptel.ac.in/courses/112101095/2

Bos Chairman

Course Code : 141CC9134	Course Title: MECHANICS OF COMPOSITE MATERIALS	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Understand the general characteristics of fibers, matrices and fiber reinforced composites
2. Understand the various manufacturing process and quality inspection methods of composite materials.
3. Understand the mechanical,fatigue and long term properties of composite materials.
4. Determine elastic moduli of composite materials such as Longitudinal Young's modulus, Transverse Young's modulus,Major Poisson's ratio,In-plane shear modulus using strength of material approach and sem-empirical model.
5. Design and analyzes of laminated composites.

UNIT I INTRODUCTION TO COMPOSITES 9

Definition – Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramic and Aramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Fiber surface treatments, Fillers and additives, Fiber content, density and void content.

UNIT II MANUFACTURING METHODS OF COMPOSITES 9

Bag Moulding – Compression Moulding – Pultrusion – Filament Winding – Other Manufacturing Processes – Quality Inspection methods. Processing of MMC –diffusion bonding – stir casting – squeeze casting.

UNIT III PERFORMANCE OF COMPOSITES 9

Static Mechanical Properties – Fatigue and Impact Properties – Environmental effects – Long term properties, Fracture Behavior and Damage Tolerance.

UNIT IV MECHANICS OF COMPOSITES 9

Rule of mixture -volume and mass fractions – density - void content, Evaluation of four elastic moduli based on strength of materials approach and Semi-Empirical model-Longitudinal Young's modulus-transverse Young's modulus–major Poisson's ratio-In-plane shear modulus, Ultimate strengths of a unidirectional lamina. Characteristics of Fiber-reinforced lamina–laminates–lamination theory, Interlaminar stresses.

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UNIT V DESIGN AND ANALYZES OF LAMINATED COMPOSITES 9

Failure Predictions, Laminate Design Consideration-design criteria-design allowables - design guidelines, Joint design-Bolted and Bonded Joints, Design Examples-Design of a tension member – design of a compression member – design of a beam-design of a torsional member, Application of FEM for design and analysis of laminated composites.

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the general characteristics of fibers, matrices and fiber reinforced composites.

CO2: Explain the various manufacturing process and quality inspection methods of composite materials.

CO3: Explain the mechanical,fatigue and long term properties of composite materials.

CO4: Determine elastic moduli of composite materials such as Longitudinal Young's modulus, Transverse Young's modulus,Major Poisson's ratio,In-plane shear modulus using strength of material approach and sem-empirical model.

CO5: Design and analyzes of laminated composites.

Text Books

1. Mallick, P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", Marcel Dekker Inc, 1993
2. Autar K. Kaw, "Mechanics of Composite Materials" CRC Press, 2006

References

1. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 1999.
2. Ronald Gibson, "Principles of Composite Material Mechanics", Tata McGraw Hill, 2007
3. Chawla K.K., "Composite materials", Springer – Verlag, 2006

Web References

- http://nptel.ac.in/courses/112104168/

Bos Chairman

Course Code : 141CC9135	Course Title: ADDITIVE MANUFACTURING	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Computer Applications in design

Course Objectives

The course is intended to:

1. Explain the importance of Rapid Prototyping Technology.
2. Design a component based on additive manufacturing environment.
3. Explain liquid based and powder based rapid prototyping process.
4. Explain solid based rapid prototyping process.
5. Select Three Dimensional Printing process

UNIT I INTRODUCTION 9

Overview – Need - Development of Additive Manufacturing Technology -Principle –AM Process Chain- Classification –Rapid Prototyping- Rapid Tooling – Rapid Manufacturing – Applications- Benefits –Case studies.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9

Design tools: Data processing - CAD model preparation – Part orientation and support structure generation – Model slicing –Tool path generation- Design for Additive Manufacturing: Concepts and objectives- AM unique capabilities – DFAM for part quality improvement- Customised design and fabrication for medical applications.

UNIT III PHOTOPOLYMERIZATION AND POWDER BED FUSION PROCESSES 9

Photo polymerization: SLA-Photo curable materials – Process - Advantages and Applications. Powder Bed Fusion: SLS-Process description – powder fusion mechanism – Process Parameters – Typical Materials and Application. Electron Beam Melting. Case studies

UNIT IV EXTRUSION BASED AND SHEET LAMINATION PROCESSES 9

Extrusion Based System: FDM-Introduction – Basic Principle – Materials – Applications and Limitations – Bioextrusion. Sheet Lamination Process: LOM- Gluing or Adhesive bonding – Thermal bonding. Case studies.

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UNIT V PRINTING PROCESSES AND BEAM DEPOSITION PROCESSES 9

Droplet formation technologies – Continuous mode – Drop on Demand mode – Three Dimensional Printing – Advantages – Bioplotter - Beam Deposition Process: LENS- Process description – Material delivery Process parameters – Materials – Benefits – Applications.

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the importance of additive manufacturing over the existing traditional methods in present competitive scenario in terms of product development cycle and cost.
CO2: Design a component based on additive manufacturing environment.
CO3: Explain the photopolymerization and powder bed fusion processes for a given applications.
CO4: Explain the extrusion based and sheet lamination processes for a given applications.
CO5: Explain the printing processes and beam deposition processes for a given applications.

Text Books

1. Ian Gibson, David W.Rosen, Brent Stucker "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing" Springer , 2010.
2. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third edition, World Scientific Publishers, 2010.

References

1. Liou W.Liou, Frank W.Liou,"Rapid Prototyping and Engineering applications : A tool box for prototype development", CRC Press, 2007.
2. Wimpenny, David Ian, Pulak M. Pandey, and L. Jyothish Kumar, eds. Advances in 3D printing & additive manufacturing technologies. Springer Singapore, 2017.

Web References

- https://additivemanufacturing.mit.edu

Bos Chairman

Course Code : 141CC9136	Course Title: RESEARCH METHODOLOGY	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Advanced Mathematics

Course Objectives

The course is intended to:

1. Explain the types of research and data collection methods.
2. Explain the types of scales and sampling methods used in the research.
3. Understand the parametric tests for concerning means and variances.
4. Understand the non-parametric tests such as one sample tests and two sample tests.
5. Explain research data analysis and report writing.

UNIT I INTODUCTION TO RESEARCH AND DATA COLLECTION 9

Research methodology – definition, mathematical tools for analysis, Types of research, exploratory research, conclusive research, modeling research, algorithmic research, Research process- steps. Data collection methods- Primary data – observation method, personal interview, telephonic interview, mail survey, questionnaire design. Secondary data- internal sources of data, external sources of data.

UNIT II SCALES AND SAMPLING METHODS 9

Scales – measurement, Types of scale – Thurstone's Case V scale model, Osgood's Semantic Differential scale, Likert scale, Q- sort scale. Sampling methods- Probability sampling methods – simple random sampling with replacement, simple random sampling without replacement, stratified sampling, cluster sampling. Non-probability sampling method – convenience sampling, judgment sampling, quota sampling.

UNIT III PARAMETRIC TESTS 9

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

UNIT IV NON PARAMETRIC TESTS 9

Nonparametric tests- One sample tests – one sample sign test, Kolmogorov- Smirnov test, run test for randomness, Two sample tests – Two sample sign test, Mann- Whitney U test, K-sample test – Kruskal Wallis test (H-Test).

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UNIT V DATA ANALYSIS AND REPORT PREPARATION 9

Introduction to Discriminant analysis, Factor analysis, cluster analysis, multidimensional scaling, conjoint analysis. Report writing- Types of report, guidelines to review report, typing instructions, oral Presentation

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the types of research and data collection methods.

CO2: Explain the types of scales and sampling methods used in the research.

CO3: Describe the parametric tests for concerning means and variances.

CO4: Describe the non-parametric tests such as one sample tests and two sample tests.

CO5: Explain research data analysis and report writing.

Text Books

1. Panneerselvam, R., Research Methodology, Prentice-Hall of India, New Delhi, 2004
2. Kothari, C.R., Research Methodology –Methods and techniques, New Age Publications, New Delhi, 2009.

References

1. Bhattacharyya D.K., Research Methodology, Excel Books Publications, New Delhi, 2006.

Web References

- https://onlinecourses.nptel.ac.in/noc16_ge01/preview

Bos Chairman

UNIT V DISSIMILAR WELDING AND WELDING DEFECTS 9

Dissimilar welding: Metallurgical problems in dissimilar welding- calculation of dilution- methods of controlling dilution - techniques of dissimilar welding- welding of various dissimilar metals combinations like steels, cast irons, Al, Cu, Mg, Ni to other alloys.

Welding Defects: Lamellar tearing and reheat cracking. Defects in welded joints: Origin, effects, and remedies. Arc welding defects, resistance welding defects, defects in friction welding, defects in welds of other welding processes

Course Outcomes

At the end of the course students will be able to:

CO1: Explain the principles of welding metallurgy.
CO2: Describe basic physical metallurgy starting at the atomic level, with bonding, defect structure, phase diagrams and diffusion and moves towards the development of metal microstructure.
CO3: Explain the welding metallurgy of alloy steels.
CO4: Explain the weldability of non–ferrous alloy steels.
CO5: Describe the techniques of dissimilar welding with welding defects.

Text Books

1. Linnert. G.E. "Welding Metallurgy", Vol. 1 and Vol.2 4th Edition. A W S. 1994.
2. Granjon. H. "Fundamentals of Welding Metallurgy". Jaico Publishing House.1994

References

1. Easterlin.K.E.,"Introduction of Physical Metallurgy of Welding", 2nd ed. Butterworth Heinmann. 2018
2. Saferian D. "The Metallurgy of Welding". Chapman and Hall. 2014.
3. Kou. S. "Welding Metallurgy", John Wiley & Sons. 2000.
4. Norman Bailey. "Weldability of Ferritic Steels". Jaico Publishing House. 2010.
5. Parmer R.S. "Welding Engineering and Technology", Khanna Publishers. 2012.

Web References

- https://www.slideshare.net/KapildevPandey/welding-metallurgy
- https://nptel.ac.in/courses/113105023/Lecture42.pdf
- https://www.elsevier.com/books/...to the...metallurgy...welding/.../ 978-0-7506-0394-2

Bos Chairman

Course Code : 141CC9137	Course Title: WELDING METALLURGY	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objectives

The course is intended to:

1. Understand the physical and welding metallurgy, and weldability of stainless steels, nickel-base alloys, aluminum alloys, and other nonferrous structural metals.
2. Understand the basics of dissimilar welding and identify the welding defects with causes and remedies.

UNIT I WELDING METALLURGY PRINCIPLES 9

Heat flow-Basic heat transfer equations, temperature distributions and cooling curves-Influence of heat input, Joint Geometry, plate thickness, preheating and other factors. Comparison of welding processes based on these considerations. Solidification – Epitaxial growth – weld metal solidification – cellular and columnar structures – effect of welding parameters .

UNIT II PHYSICAL METALLURGY OF WELDING 9

Welding Of Ferrous Materials: Iron – Carbon Diagram, TTT And CCT Diagrams, Effects Of Steel Composition, Formation Of Different Micro structural Zones In Welded Plain-Carbon Steels. Welding Of C- Mn And Low-Alloy Steels, Phase Transformations In Weld And Heat – Affected Zones, Cold Cracking, Role Of Hydrogen And Carbon Equivalent, Formation Of Acicular Ferrite And Effect On Weld Metal Toughness.

UNIT III WELDING OF ALLOY STEELS 9

Welding Of Stainless Steels, Types Of Stainless Steels, Overview Of Joining Ferritic And Martensitic Types, Welding Of Austenitic Stainless Steels, Hot Cracking, Sigma Phase And Chromium Carbide Formation, Ways Of Overcoming These Difficulties, Welding Of Cast Iron.

UNIT IV WELDABILITY OF NON-FERROUS ALLOYS 9

Weldability of aluminum and its alloys, copper and its alloys, Titanium and its alloys Ni and its alloys and Mg and its alloys – Selection of welding process and procedure appropriate for each material.

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