MECHANICAL ENGINEERING
CREDIT COURSES SYLLABUS

ADVANCED FINITE ELEMENT ANALYSIS

UNIT I

Formulation Techniques: Basic principles of theory of elasticity, finite elements, Raleigh Ritz and Galerkin Methods. Coordinates, boundary conditions, Element matrices, assembling of global stiffness matrix, Finite Element Solution methods.

UNIT II

Trusses, Beams & Frames: Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses, temperature effects.

UNIT III

Two dimensional problems: four noded and eight nodded rectangular elements, Lagrange basis for rectangles, serendipity interpolation functions. Axisymmetric Problems: Axisymmetric formulations, Element matrices, boundary conditions. Heat Transfer problems: Conduction and convection, examples: - two dimensional fin.

UNIT IV

Isoparametric formulation: Concepts, sub parametric, super parametric elements, numerical integration. Applications of Isoparametric elements for structural and dynamic problems.

UNIT V

Convergence, Solution improvement methods, patch test, formulation methods of geometric and material non linear problems, case studies on coupled analysis problems. Implementation of FEA problems through MAT Lab.

Suggested Assignment:
To refer ASME Series of *Journal of Engineering Materials and Technology, Journal of Mechanical Design,* Elsevier Publishers *Finite Elements in Analysis and Design, Simulation modeling Practice and Theory* for giving a seminar on any current topic of relevance.

REFERENCE BOOKS :

1. R.D.Cook, Introduction to Finite Element Analysis, John Wiley & sons
2. T.J.R Hughes, The Finite Element Method: Linear and Dynamic Finite Element Analysis, Dover Publications
3. J.N. Reddy, Finite element method in Heat transfer and fluid dynamics, CRC press
4. Zienckiwicz O.C. & R. L. Taylor, Finite Element Method, McGraw-Hill
5. J. N. Oden, Finite Element of Nonlinear continua, McGraw-Hill, New York
6. K. J. Bathe, Finite element procedures, Prentice-Hall

MECHANICAL ENGINEERING
CREDIT COURSES SYLLABUS

ADVANCED OPTIMIZATION TECHNIQUES

UNIT I

Linear programming: Two-phase simplex method, Big-M method, duality, interpretation, applications.
Assignment problem: Hungarian's algorithm, Degeneracy, applications, unbalanced problems, traveling salesman problem.

UNIT II

Classical optimization techniques: Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions.
Numerical methods for optimization: Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method, types of penalty methods for handling constraints.

UNIT III

Genetic algorithm (GA) : Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA,

UNIT IV

Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.
Multi-Objective GA: Pareto's analysis, Non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems .

UNIT V

Applications of Optimization in Design and Manufacturing systems: Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.

Suggested Assignment:
To refer ASME Series of *Journal of Engineering Materials and Technology, Journal of Mechanical Design,* Elsevier Publishers *Finite Elements in Analysis and Design, Simulation modeling Practice and Theory* for giving a seminar on any current topic of relevance.

TEXT BOOKS:

1. Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers
2. Optimization for Engineering Design – Kalyanmoy Deb, PHI Publishers
3. Engineering Optimization – S.S.Rao, New Age Publishers

REFERENCES:

1.Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers
2. Genetic Programming- Koza
3. Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers

MECHANICAL ENGINEERING
CREDIT COURSES SYLLABUS

NANO TECHNOLOGY

AIM

The aim is to appreciate the students with the background, applications and current status of nanotechnology and nanomaterials, and to make them understand the relevant basic scientific principles underpinning nanotechnology.

OBJECTIVES:

At the end of this course the students are expected to understand the general issues relating to nanotechnology and nanofabrication.

- Methods for production of Nanoparticles
- Characteristic techniques of nanomaterials

UNIT I

INTRODUCTION TO NANOMATERIALS:

Amorphous, crystalline, microcrystalline, quasi-crystalline and nano-crystalline materials. Historical development of nanomaterials – Issues in fabrication and characterization of nanomaterials

UNIT II

SYNTHESIS OF NANOMATERIALS:

Methods of production of Nanoparticles, Sol-gel synthesis, Inert gas condensation, High energy Ball milling, Plasma synthesis, Electro deposition and other techniques.

Synthesis of Carbon Nanotubes – Solid carbon source based production techniques, Gaseous carbon source based production techniques - Growth mechanisms

Nano wires.

UNIT III

CHARACTERISATION OF NANOMATERIALS:

Scanning Probe Microscopy (SPM) – Scanning tunneling microscope, Transmission electron microscope, Scanning transmission electron microscope, Atomic force microscope, Scanning force microscopy, Electrostatic force microscopy , Dynamic force microscopy, Magnetic force microscopy, Scanning thermal microscopy, Peizo force microscopy, scanning capacitance microscopy, Nano indentation.

UNIT IV

APPLICATIONS OF NANOMATERIALS:

Applications in Mechanical, Electronics engineering industries – Use of nanomaterials in automobiles, aerospace, defense and medical applications – Metallic, polymeric, organic and ceramic nanomaterials.

UNIT V

MECHANICAL ENGINEERING
CREDIT COURSES SYLLABUS

NANO FABRICATION AND MACHINING:

LIGA, Ion beam etching, Molecular manufacturing techniques – Nano machining techniques –, Top/Bottom up Nano fabrication techniques - Sub micron lithographic technique, conventional film growth technique, Chemical etching, Quantum materials.

Suggested Assignment:
To refer IEEE Transactions on *Nano Technology* and ASME Series *Journal of Nano Technology in Engineering and Medicine* for giving a seminar on any current topic of relevance.

TEXT BOOKS:

1. A.K. Bandyopadhyay, " Nano Materials", New Age International Publishers, New Delhi, 2007
2. Bharat Bhushan, "Handbook of Nanotechnology", Springer, Germany, 2004.

REFERENCES:

1. Mark Ratner and Daniel Ratner, "Nano Technology", Pearson Education, New Delhi, 2003.
2. Gregory Timp, "Nanotechnology", Springer, India, 2005

Ahmed Busnaina, "Nanomanufacturing Handbook", CRC Press, London, 2006

MECHANICAL ENGINEERING
CREDIT COURSES SYLLABUS

ADVANCED MECHANICS OF SOLIDS

UNIT I

Shear center: Bending axis and shear center-shear center for axi-symmetric and unsymmetrical sections

Unsymmetrical bending: Bending stresses in Beams subjected to Nonsymmetrical bending; Deflection of straight beams due to nonsymmetrical bending.

UNIT II

Curved beam theory: Winkler Bach formula for circumferential stress – Limitations – Correction factors – Radial stress in curved beams – closed ring subjected to concentrated and uniform loads-stresses in chain links.

Torsion : Linear elastic solution; Prandtl elastic membrane (Soap-Film) Analogy; Narrow rectangular cross Section ;Hollow thin wall torsion members ,Multiply connected Cross Section.

UNIT III

Contact stresses: Introduction; problem of determining contact stresses; Assumptions on which a solution for contact stresses is based; Expressions for principal stresses; Method of computing contact stresses; Deflection of bodies in point contact; Stresses for two bodies in contact over narrow rectangular area (Line contact), Loads normal to area; Stresses for two bodies in line contact, Normal and Tangent to contact area.

UNIT IV

Two Dimensional Elasticity Problems: Plane stress & Plain strain-Problems in Rectangular Co-ordinates, bending of cantilever loaded at the end, bending of a beam by uniform load.

Two Dimensional Elasticity Problems in polar co-ordinates, general equations in polar coordinates, stress distribution symmetrical about an axis, pure bending of curved bars, displacements for symmetrical stress distributions, rotating discs.

UNIT V

Introduction to Three Dimensional Problems: Uniform stress stretching of a prismatical bar by its own weight, twist of circular shafts of constant cross section, pure bending of plates.

Suggested Assignment:

To refer ASME Series of *Journal of Engineering Materials and Technology, Journal of Mechanical Design,* Elsevier Publishers *International Journal of Solids and Structures* for giving a seminar on any current topic of relevance.

TEXTBOOKS:

1.Advanced Mechanics of materials by Boresi & Sidebottom-Wiely International.

2. Theory of elasticity by Timoschenko S.P. and Goodier J.N. McGraw-Hill Publishers 3rd Edition

REFERENCES:

1. Advanced strength of materials by Den Hortog J.P.
2. Theory of plates – Timoshenko.
3. Strength of materials & Theory of structures (Vol I & II) by B.C Punmia
4. Strength of materials by Sadhu singh

MECHANICAL ENGINEERING
CREDIT COURSES SYLLABUS

HYDROGEN AND FUEL CELLS

AIM:

To enlighten the student community on various technological advancements, benefits and prospects of utilizing hydrogen/fuel cell for meeting the future energy requirements.

OBJECTIVE:

- To detail on the hydrogen production methodologies, possible applications and various storage options
- To discuss on the working of a typical fuel cell, its types and to elaborate on its thermodynamics and kinetics
- To analyze the cost effectiveness and eco-friendliness of Fuel Cells

UNIT I

HYDROGEN – BASICS AND PRODUCTION TECHNIQUES

Hydrogen – physical and chemical properties, salient characteristics.Production of hydrogen – steam reforming – water electrolysis – gasification and woody biomass conversion – biological hydrogen production – photo dissociation – direct thermal or catalytic splitting of water.

UNIT II

HYDROGEN STORAGE AND APPLICATIONS Hydrogen storage options – compressed gas – liquid hydrogen – Hydride – chemical Storage – comparisons.Hydrogen transmission systems.Applications of Hydrogen.

UNIT III

FUEL CELLS

History – principle - working - thermodynamics and kinetics of fuel cell process – performance evaluation of fuel cell – comparison on battery Vs fuel cell

UNIT IV

FUEL CELL - TYPES

Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC – relative merits and demerits

UNIT V

APPLICATION OF FUEL CELL AND ECONOMICS

Fuel cell usage for domestic power systems, large scale power generation, Automobile, Space. Economic and environmental analysis on usage of Hydrogen and Fuel cell. Future trends in fuel cells.

Suggested Assignment:

To refer SAE Transactions *International Journal of Fuels and Lubricants* ASME Series of *Journal of Fuel Cell Science and Technology,* AIAA Transactions of *Energy* Elsevier Publishers *International Journal of Hydrogen Energy* for giving a seminar on any current topic of relevance.

TEXT BOOKS:

1. Rebecca L. and Busby, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Corporation, Oklahoma (2005)
2. Bent Sorensen (Sørensen), Hydrogen and Fuel Cells: Emerging Technologies and Applications, Elsevier, UK (2005)

REFERENCES:

1. Kordesch, K and G.Simader, Fuel Cell and Their Applications, Wiley-Vch, Germany (1996).
2. Hart, A.B and G.J.Womack, Fuel Cells: Theory and Application, Prentice Hall, NewYork Ltd., London (1989)
3. Jeremy Rifkin, The Hydrogen Economy, Penguin Group, USA (2002). Viswanathan, B and M Aulice Scibioh, Fuel Cells – Principles and Applications, Universities Press (2006)

MECHANICAL ENGINEERING
CREDIT COURSES SYLLABUS

COMPUTER INTEGRATED MANUFACTURING

UNIT I

Introduction: Fundamental concepts in Manufacturing and Automation, Automation Strategies, Economic analysis in production, fundamentals of CAD / CAM, product cycle and CAD/CAM,

Automation and CAD/CAM: Scope of CIM, Automated flow lines, Transfer mechanisms, methods of Line balancing.

UNIT II

Conventional Numerical control: Introduction- basic components of an NC system-the NC procedure- NC coordinate system, NC motion control system- application of numerical control- Economics of Numerical control.

UNIT III

NC part programming: Introduction - part programming methods - Computer assisted part programming, APT Language, macro statement in APT. NC programming with manual data input.

Computer controls in NC: NC controllers' technology - Computer Numerical Control (CNC), Direct Numerical control (DNC), Adaptive control machining systems: Adaptive control optimization, Adaptive control constraint.

UNIT IV

Group Technology: Part families, parts classification and coding, production flow analysis, Composite part concept, Machine cell design, benefits of GT.

Flexible Manufacturing Systems: Components of FMS, FMS Work stations, Material Handling Systems, and Computer Control system, FMS layout configurations and benefits of FMS.

UNIT V

Computer aided planning systems: Approaches to Computer aided Process Planning (CAPP) - Generative and Retrieval CAPP systems, benefits of CAPP, Material Requirement Planning(MRP), mechanism of MRP, benefits, and Capacity Planning. Computer process control - Computer Process monitoring and control.

Suggested Assignment:

To refer ASME Series of *Journal of Manufacturing Science and Engineering,* Springer Publishers *International Journal of Advanced Manufacturing Technology* SAE Transactions *International Journal of Materials and Manufacturing* for giving a seminar on any current topic of relevance.

TEXT BOOKS:

1. CAD/CAM - Mikell P.Groover, and Emory W.Zimmers.Jr.
2.Automation,Production systems and Computer Integrated Manufacturing Systems – Mikel P.Groover.
3.CNC machines – Adithan and Pabla,New Age Publications
4. Computer Automated Manufacturing - David Bed Worth
5. Understanding CAD/CAM by DAVID J.Bowman

MECHANICAL ENGINEERING
CREDIT COURSES SYLLABUS

Research Tools in Science and Technology

UNIT-1

Fundamentals of Neural Networks: Basic Concepts of Neural Networks, Human Brain, Model of an Artificial Neuron, Neural Net Work Architecture, Single Layer Feed Forward Network

Multi Layer Feed Forward Network, Recurrent Networks, Characteristic of Neural Networks, Taxonomy of Neural Network Architectures. Perceptron – Architecture, Algorithm, Mathematics, Limitations-XoR problem, Local Minima etc.

Multi-Layer Perceptron – Solution to XoR problem, Architecture, Back Propagation Algorithm, Mathematics, Learning Difficulties in Multi-Layer Perceptron.

Hopfield Network – Architecture, Algorithm, Mathematics, Limitations of Hopfield Network, Applications of Hopfield Network for Travelling Sales man problem.

UNIT-2

Fuzzy Logic-Fuzzy Set Theory:

Fuzzy sets – Basic Definitions, Types of Fuzzy sets, Operations on Fuzzy sets, Fuzzy measures and measures Fuzziness, Operations for Fuzzy sets and Fuzzy numbers, Fuzzy relations,

Applications of Fuzzy set theory for Experts systems and Fuzzy control, Pattern Recognition

UNIT-3

Finite Element Methods: Discretization, Assembly, Stiffness matrix, Solution of simultaneous algebraic equations, Procedural steps in FEM, Solution of Differential equations using FEM, Weighted residual method, Galerkin's method, Total potential energy approach, Convergence criteria, p-method, h-method, general applications.

UNIT-4

Optimization - Genetic Algorithm (GA): Shortfalls of conventional algorithms, Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA.

Multi-Objective GA: Pareto's analysis, Non-dominated front, multi-objective GA, Non-dominated sorted GA, Operators, Convergence criterion, and Applications of multi-objective problems.

UNIT- 5

Continuous and Discrete Wavelet Transform

Fourier series and Geometry: Vector space, Function and function spaces, Complex Fourier series

Continuous wavelet transform and Short time Fourier Transform: Introduction, Wavelet Transform – A first level introduction, Mathematical preliminaries – Fourier Transform, Uncertainty Principle for Short term

Fourier Transform and Wavelet transform, Properties of wavelets used in Continuous wavelet transform, Continuous versus Discrete Wavelet transform

Discrete Wavelet Transform: Introduction, Haar scaling functions and Function spaces, Haar wavelet transform, Orthogonality of Ø(t) and ψ(t), Normalization of Haar Bases at different scales,

Signal Decomposition, Relation with Filter Banks, Frequency response, Signal Reconstruction: Upsampling and Filtering, Perfect matching filters

Text Books:

1. Neural Networks, Fuzzy Logic, and Genetic Algorithms – S.Rajasekaran, G.A.Vijayalakshmi Pai, PHI Publishers.
2. Fuzzy set theory and its applications – H. J. Zimmermann, Allied publications, Second edtion
3. Insight into Wavelets-From theory to practice – K. P. Soman, KI Ramachandran, PHI, Second edition
4. Fundamentals of wavelets, Theory, Algorithms, and Applications – Jaideva C. Goswami and Andrew K. Chan, Wiley India edition
5. Optimization in Engineering Design – Kalyanmoy Deb, John Wiley Publishers
6. Multi-objective optimization - Kalyanmoy Deb, John Wiley & Sons Publishers
7. Finite Element Methods – David V Hutton, TMH Publishers