Revised Scheme of Studies for PhD
In
Mechanical Engineering

DEPARTMENT OF MECHANICAL ENGINEERING
FACULTY OF ENGINEERING AND TECHNOLOGY,
INTERNATIONAL ISLAMIC UNIVERSITY ISLAMABAD,
PAKISTAN

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الجامعة الإسلامية العالمية
International Islamic University, Islamabad
Faculty of Engineering & Technology
Department of Mechanical Engineering

Scheme of Studies for PhD in Mechanical Engineering

Degree
PhD in Mechanical Engineering (PhDME)

Degree Requirement:

- PhDME: Course work of 18 credit hours plus Comprehensive examination plus research work (Total credit hours=54 (Course work: 18 Credit hours + thesis: 36 credit hours)
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Duration of the Program

- PhDME: Three to five years

Pre-requisite for the program

For PhDME: 18 years education in the relevant area of Engineering or MS/M. Phil Mechanical Engineering , with a minimum CGPA 3.00/4.00 or equivalent with minimum 70% marks + University's Admission Test/ Interview.

Intake
Twice in a year (Spring & Fall Semester)

Details Courses for MS and PhD in Mechanical Engineering

Course guide lines for PhD ME Students

1. There will be no compulsory course for PhD student. The courses to be taken by PhD student will be decided by the PhD committee before the beginning of the first semester.
2. PhD scholar will have to take at least courses worth 18 credit hours.
3. The PhD student will have to follow HEC road map (App-I).

Evaluation and Grading:

A detailed account on evaluation criteria and grading policy can be found in Graduate Hand Book. This is in line with IIUI's policies and HEC's guidelines.

More details regarding course work, comprehensive, approval of synopsis, grading semester and thesis evaluation are available in "IIUI RULES, REGULATIONS AND PROCEDURES REGARDING ADMISSIONS, REGISTRATION AND EXAMINATIONS OF MS OR EQUIVALENT AND PhD PROGRAMMES

Table 1: Road Map for PhDME program

1st Semester	**Course code**	**Course Title**	**Lec Hrs.**	**Credit Hours**
	XXXXX	Course-I	3	3
	XXXXX	Course-II	3	3
	XXXXX	Course-III	3	3
	Total Credit Hours		**9**	**9**
2nd Semester	**Course Code**	**Course Title**	**Lec Hrs.**	**Credit Hours**
	XXXXX	Course-IV	3	3
	XXXXX	Course-V	3	3
	XXXXX	Course-VI	3	3
	Total Credit Hours		**9**	**9**
	Course Code	**Course Title**	**Lec Hrs.**	**Credit Hours**
	ME 999	Research Thesis	36	36
	Total Credit Hours		**36**	**36**
	Total Credit Hours of Degree		**54**	**54**

Course Code Methodology: ME = Mechanical Engineering
First Numeric = Level of knowledge
Second and Third Numeric = Serial number

List of Courses

PhD Courses

S. No	Course Code	Course Title	Credit hours
1	ME701	Fatigue Analysis	3
2	ME702	Tribology	3
3	ME703	Nonlinear Vibration	3
4	ME704	EngineeringAcoustics	3
5	ME705	Experimental Methods In Fluid	3
6	ME706	Energy Management	3
7	ME707	Advanced Statistics And Data Mining	3
8	ME708	Engineering Optimization Techniques	3
9	ME709	Design Of Advanced Manufacturing Systems	3
10	ME710	Industrial Cost Management	3
11	ME711	Product Life Cycle Management	3
12	ME712	Human Resources Management And Organizational Behavior	3
13	ME 713	MEMS and Micromachining	3
14	ME801	Advanced Stress Analysis	3
15	ME802	Continuum Mechanics	3
16	ME803	Special Topics In Design Engineering	3
17	ME804	Modal Analysis	3
18	ME805	Advanced Automatic Control Systems	3
19	ME806	Special Topics In Dynamics And Control	3
20	ME807	Special topic in Thermodynamics	3
21	ME808	Special topic in Fluid Mechanics	3
22	ME809	Advanced Heat Transfer	3
23	ME810	Special Topics In Mechanical Power Engineering	3
24	ME811	Advanced CAD/CAM	3
25	ME812	Computer Integrated Manufacturing	3
26	ME813	Simulation Modeling Of Manufacturing Systems	3
27	ME814	Statistical Quality Control And Assurance	3
28	ME815	Computer Aided Process Planning	3
29	ME816	Special Topics In Manufacturing Engineering	3
30	ME817	Supply Chain Management	3
31	ME818	Special Topics In Engineering Management	3

Course Outlines

ME 701	**Fatigue Analysis**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	• To describe faigue failure design • To develop comprehensive knowledge of the fatigue failure • To develop skills for design against fatigue	
Course Outline	Nature of fatigue failure, crack nucleation and crack propagation. Fatigue testing machines. High cycle fatigue. The SNP curves and factors affecting SNP curves. The influence of non-zero mean stresses. Multiaxial fatigue stresses and fatigue failuretheories. Commutative fat/gue damage and life prediction. Low cycle fatigue. The	

	strain-life curve and low cycle fatigue relationships. Commutative damage in low cycle fatigue. Fatigue stress concentration factors for elastic and plastic ranges.	
Recommended Books	1. Schijve, J., and T. U. Delft. "Fatigue of Structures and Materials' Kluwer Academic Publishers." PO Box 17: 3300. 2. Stephens, Ralph I., et al. Metal fatigue in engineering. John Wiley & Sons, 2000.	
ME 702	**TRIBOLOGY**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	• To understand mechanisms of wear, erosion and corrosion • To develop skills for the design selection of lubrication	
Course Outline	Theories of friction. Mechanism of wear, adhesive, abrasive, corrosive and other types of wear & measurement, lubricants, properties, hydrostatic & hydrodynamic lubrication, Elasto-hydro-dynamic lubrication, solid film lubrication, and boundary lubrication, Bearing types and selection, Design procedure and performance evaluation.	
Recommended Books	*Tribology: friction and wear of engineering materials, Ian M Hutchings, Edward Arnold, 1992* *Tribology: principles and design applications, RD Arnell, Macmillam, 1991*	

ME 703	**Nonlinear Vibration**	**3(3+0)**
Pre-Requisite	• Mechanical Vibration • Engineering Mechanics	
Course Objectives	To 1. demonstrate understanding of the essentials of linear vibration theory, for single degree-of-freedom (dof) systems and for multi dof systems 2. model and analyse four classes of response suppression techniques applicable to multi dof linear systems, namely passive isolation, passive damping, active isolation, active damping	
Course Outline	Introduction: linear and nonlinear systems, conservative and non-conservative systems; potential well, Phase planes, types of forces and responses, fixed points, periodic, quasi-periodic and chaotic responses; Local and global stability; commonly observed nonlinear phenomena: multiple response, bifurcations, jump phenomena. Development of nonlinear governing equation of motion of Mechanical systems, linearization techniques, ordering techniques; commonly used nonlinear equations: Duffing equation, Van der Pol's oscillator, Mathieu's and Hill's equations. Analytical solution methods: Harmonic balance, perturbation techniques (Linstedt-Poincare', method of Multiple Scales, Averaging – Krylov-Bogoliubov-Mitropolsky), incremental harmonic balance, modified Lindstedt Poincare' techniques.Stability and bifurcation analysis: static and dynamic bifurcations of fixed point and periodic response, different routes to chaotic response (period doubling, torus break down, attractor merging etc.), crisis. Numerical techniques: time response, phase portrait, FFT, Poincare' maps, point attractors, limit cycles and their numerical computation, strange attractors and chaos; Lyapunov exponents and their determination, basin of attraction: point to point mapping and cell to cell mapping, fractal dimension. Application: Single degree of freedom systems: Free vibration-Duffing's oscillator; primary-, secondary-and multiple- resonances; Forced oscillations: Van der Pol's oscillator; parametric excitation: Mathieu's and Hill's equations, Floquet theory; effects of damping and nonlinearity. Multi degree of freedom and continuous systems.	
Recommended Books	- Dimarogonas, A. Vibration for Engineers. Second edition. Prentice-Hall, 1996. - Harris, C.M. and Piersol, A.G. Harris's Shock and Vibration Handbook. Fifth edition.	

	McGraw-Hill, 2002. - Inman, D.J. Engineering Vibration. Prentice-Hall, 1996. See especially chapter 10 on nonlinear vibrations (only in this first edition!) - Jordan, D.W. and Smith, P. Nonlinear Ordinary Differential Equations - an Introduction to Dynamical Systems. Third edition. Oxford University Press, 1999. - Kelly, S.G. Fundamentals of Mechanical Vibrations. Second edition. McGraw-Hill International Editions, 2000.	
ME 704	**ENGINEERING ACOUSTICS**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	1. Calculate the displacement and velocity of a second-order mechanical system assuming simple harmonic motion with loss and with forced harmonic excitation. 2. Derive the one-dimensional wave equation for transverse waves on a string.	
Course Outline	Vibration & Waves: How are time and space related? What about the relation between frequency and wavelength?Does the characteristic impedance of medium determine reflection and transmission?Do we well see the waves of a string in terms of driving point impedance?Acoustics Wave Equation and Its Basic Physical Measures (1D acoustic wave equation, Acoustic Intensity and Energy, Units of Sound) What are the relations of acoustic pressure, density, and particle velocity?How do they make acoustic wave equation?Is acoustic wave well analogous with one dimension string wave?Acoustics Wave Equation and Its Basic Physical Measures (Acoustic Intensity and Energy, Solutions of the Wave equation, Demonstration: hearing system) What about the relation between acoustic intensity and energy? How does human hearing system measure sound and its characteristics?Let us experience the change of sound in level and frequency! Waves on a Flat Surface of Discontinuity(Normal incidence on a Flat Surface, The Mass Law)How mathematically express the boundary conditions at discontinuity?How does impedance at discontinuity determine reflection and transmission?When can we use mass law? Waves on a Flat Surface of Discontinuity(Transmission Loss, Snell's Law, Transmission and Reflection of an Infinite Plate/Finite Structure)How different is the transmission loss of a flexible partition compared to the mass law?Does the obliqueness of wave play a critical role to determine transmitted and reflected wave?What are the roles of partition and fluid loading impedance to transmission loss?	
Recommended Books	1. Sound Propagation: An Impedance Based Approach by, Yang-Hann Kim (Wiley & Sons, 2010).	

ME 705	**EXPERIMENTAL METHODS IN FLUID**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	• To introduce students to a selection of currently used experimental methods for measuring fluid flows. • To expose the student to the limitations of experimental measurement systems and the validity of the produced data. • To introduce the importance of estimating and reporting uncertainty levels in experimental data	
Course Outline	Instruments for measurement in fluid flow: monitoring and controlling processes,	

	engineering analysis, categories of flow, instrumentation in thermo-fluids, planning, designing and carrying out experiments, stages of an experimental investigation. Pressure differential devices: incompressible and compressible flow cases, idealized analysis of flow meters, practical flowmeters, Rota meter, idealized analysis, use with gases, calibration. Turbulence and Reynolds number: 2-D nozzle jet flow, time-dependent flow, coordinates and notation of the actual, mean and fluctuating components of flow velocity, time-averaged quantities, case studies. Pressure measurements: measurement at wall, manometers and instruments, pressure transducers, Pitot tubes (probes) performance, error sources, Pitot-static tubes performance. Flow system: open and closed circuit wind tunnels, high-pressure and /high-temperature closed circuit wind tunnels, working section, use of screens, meshes, gauzes, course meshes, honeycombs, nozzles, diffusers, contractions, bell-mouth contractions, refracting meshes, splitter plates, guide vans, blowing (Coanda effect), boundary layer suction, corners, corner vanes. Hot wire anemometry (HWA): measurement of mean and fluctuating components of velocity, HW response, King's law, Constant current (CCA) and constant temperature anemometers (CTA), calibration procedures, directional characteristics, normal yawed and crossed wires, processing the hotwire signals. Hot film anemometry, HWA versus HFA. Laser Doppler Anemometry (LDA): basic Doppler effect, laser light properties, components of LDA system, general schematic of an LDA system, 2-beam LDA system, signal processing, counters and trackers, Bragg cell, forward and backward LDA, choice between LDA, HWA and HFA. Transducers: strain gauge, Piezo-electric, diaphragm pressure transducers, measurement of mechanical displacement, velocity, acceleration, rotational speed. Combustion flow measurements: measurement of temperature, pressure, velocity, density, pollutants, NO x , SO x ,HO x ,HC, and fuel concentrations, Particle sizing: mean droplet size, size distribution of droplets, droplet velocities, and trajectories, mean droplet diameters, non-intrusive techniques, spark photography, light scattering- laser diffraction, single particle counting, soot particles. High-speed cine film photography, holography, use of digital camera for experimentation and flow visualization in thermo-fluids.
Recommended Books	1. Springer Handbook of Experimental Fluid Mechanics, Volume 1, edited by Cameron Tropea, Alexander L. Yarin, John F. Foss, Springer, 2007, ISBN: 3540251413, 9783540251415. 2. Hot Wire Anemometry: Principles and Signal Analysis *Oxford science publications, by* H. H. Bruun, edition: illustrated, reprint, Oxford University Press, 1995, ISBN: 0198563426, 9780198563426. 3. Fluid Mechanics Measurements, by R. Goldstein, Publisher: CRC Press; 2nd edition (March 1, 1996), ISBN-10: 156032306X, ISBN-13: 978-1560323068.
ME 706	**ENERGY MANAGEMENT** 3(3+0)
Pre-Requisite	NIL
Course Objectives	• *Knowledge of how economic analysis can help understand problems related to energy;* • *To analyse alternative energy policy options in terms of benefits and costs;* • *To have a good understanding of world energy markets;* • *To analyse the risks associated with energy options.* • *Skills needed to structure, analyse and evaluate energy-related problems*
Course Outline	Energy scene, Thermodynamics and energy, heat and mass transfer, waste heat recovery, vapor diffusion and condensation. Energy surveys and energy audits; laws of energy and materials flows, checklists for energy managers, case study generation, evaluation and optimization of options for energy conservation
Recommended Books	1. Energy management: theory and practice, vol 8 of energy, power and environment, HW Henry, M. Dekker, 1980 2. Guide to energy management, BL Capehart, WC Turner and WJ Kennedy, fourth ed.,

	Fairmont press inc. 2002	
ME 707	**ADVANCED STATISTICS AND DATA MINING**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	To get the student acquainted with a set of computational tools in which the learned techniques can be applied. This may involve tackling practical problems from the students own work environment, i.e., working with a student's own data set.	
Course Outline	*Searching by similarity*: Searching by content (texts, images, genes, ...); attributes, representations and definitions of similarity and distance; choice of representation; multi-dimensional scaling; classifications; image search and invariants; user feedback; evaluating searches *Information*: information and uncertainty; classes and attributes; interactions among attributes *Clustering*: supervised and unsupervised learning; categorization; unsupervised category-learning, a.k.a. clustering; *k*-means clustering; hierarchical clustering; geometry of clusters; what makes a good cluster? *Data-reduction and feature-enhancement*: Standardizing data; using principal components to eliminate attributes; using factor analysis to eliminate attributes; limits and pitfalls of PCA and factor analysis; nonlinear dimensionality reduction: local linear embedding, diffusion maps *Regression* Review of linear regression; transformations to linearity; the truth about linear regression; local linear regression; polynomial regression; kernel regression; additive models; other non-parametric methods *Prediction*: Evaluating predictive models; over-fitting and capacity control; regression trees; classification trees; combining predictive models; forests; how to gamble if you must *Classification*: Supervised categorization; linear classifiers; logistic regression; the kernel trick; base rates, Neyman-Pearson classifiers, ROC curves *Distributions*: Histograms and the fundamental theorem of statistics; kernel density estimation; conditional density estimation; relative distributions; mixture models, probabilistic clustering, the EM algorithm; clustering with confidence; large numbers of rare events*Modeling interventions*: Estimating causal impacts without experiments; matching; graphical causal models and Tetrad.*Waste and Abuse*: when data mining will fail: bad data, wrong data, insufficient data, overwhelming false positives, impossible problems, attacking the wrong problem; when data mining is evil; some failures	
Recommended Books	1. Principles of Data Mining by Hand, Mannila and Smyth. 2. Berk'sStatistical Learning from a Regression Perspective (Powell's; publisher)	
ME 708	**ENGINEERING OPTIMIZATION TECHNIQUES**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	To provide engineering students interested in CAE/CAD an engineering view of optimization as a tool for design. The course will concentrate on the mathematical and numerical techniques of optimization as applied to engineering problems Introduction to optimization techniques for engineering students. Minimization of unconstrained functions of several variables: steepest descent, Newton/Raphson, conjugate gradient, and quasi-Newton methods. Rates of convergence. Methods for constrained minimization: Introduction to linear programming and gradient projection methods. Lagrangian methods	
Course Outline	Introduction to the formulation of optimization problems. Unconstrained optimization. Zero order search. Random walk.	

	Adaptive creep. Powell's method. First order search.Gradient, Conjugate gradient methods.Second order search. Newton-Raphson, Davidon-Fletcher-Powell. Constrained optimization. Penalty methods. Direct methods of constrained optimization.Linear programming.Sensitivity analysis. Multi-objective - pareto - optimization. Equality constraints, Cumulative constraints. Law of diminishing returns and function approximation concepts. Sensitivity of objective function and Lagrange Multipliers. Goal Programming. Primal Dual Methods.Generalized Reduced Gradients. Dynamic Programming. Integer Programming. Sensitivity of optimum to problem parameters.Multi-level optimization. Optimization of complex engineering problems.Non-traditional tools of optimization - Genetic algorithms, Simulated annealing.
Recommended Books	1. Belegundu A. and T. Chandrupatla Optimization Concepts and Applications in Engineering, Prentice Hall, 1999. 2. Gen, M. and R. Cheng, Genetic Algorithms and Engineering Optimization, Wiley, 2000. 3. Edgar, T.F., Himmelblau, D.M., and L.S. Lasdon, Optimization of Chemical Processes, McGraw Hill, 2001. Download PDF
ME 709	**DESIGN OF ADVANCED MANUFACTURING SYSTEMS** 3(3+0)
Pre-Requisite	NIL
Course Objectives	The students will learn to: • Identify the components and characteristics of manufacturing systems. • Identify appropriate performance metrics of different manufacturing systems. • Develop mathematical models to describe manufacturing systems. • Develop computer-based models to simulate manufacturing systems.
Course Outline	Fundamentals of manufacturing systems, Production planning and control Just in Time Manufacturing,Theory of constraints Constant Work in Process, MRP-I , MRP-IISystem variability analysis and role of quality measurements, Shop floor control analysis, Push pull interface analysis System modeling and simulation (using Rockwelll Arena/SIMIO simulation package), System performance and influencing factors analysis Contemporary control policies and decision making
Recommended Books	1. Design of Advanced Manufacturing Systems, Models for Capacity Planning in Advanced Manufacturing Systems by Matta, Andrea, Semeraro, Quirico (Eds.) 2. Manufacturing Systems Modeling and Analysis by Curry, Guy L., Feldman, Richard M.
ME 710	**INDUSTRIAL COST MANAGEMENT** 3(3+0)
Pre-Requisite	NIL
Course Objectives	1. Describe a cost management system, its objectives, and its major systems. 2. Identify the current factors affecting cost management. 3. Describe how management accountants function within an organization
Course Outline	Introduction to Cost Management , Basic Cost Management Concepts, Cost Behavior, Activity-Based Costing, Product and Service Costing: Job-Order System, Product and Service Costing:A Process Systems Approach, Strategic Cost Management, The Balanced Scorecard: Strategic-Based Control,

	Cost-Volume-Profit Analysis
Recommended Books	1. Cost Management, Accounting & Control by Hansen- Mowen Guan
ME 711	**PRODUCT LIFE CYCLE MANAGEMENT** 3(3+0)
Pre-Requisite	NIL
Course Objectives	• *Product Lifecycle Management* to reflect the many advances made in PLM. • It includes descriptions of PLM technologies and examples of implementation projects in industry. • *Product Lifecycle Management* will broaden the understanding of PLM, nurturing the skills needed to implement PLM successfully and to achieve world-class product performance across the lifecycle.
Course Outline	*Product Lifecycle Management* explains what Product Lifecycle Management (PLM) is, and why it's needed. It describes the environment in which products are developed, realised and supported, before looking at the basic components of PLM, such as the product, processes, applications, and people. It addresses the implementation of PLM, showing the steps of a project or initiative, and typical activities. PLM is a mission-critical decision-making system leveraged by the world's most innovative companies to transform their process of innovation on a continuous basis. That is a powerful value proposition in a world where the challenge is to get better products to the market faster than ever before. That is the power of PLM
Recommended Books	1. Product Lifecycle Management: 21st Century Paradigm for Product Realisation (Decision Engineering) by John Stark, 2011. ISBN-13: 978-0857295453 2. Product Lifecycle Management: Driving the Next Generation of Lean Thinking by Michael Grieves 3. Product Lifecycle Management by AnttiSaaksvuori
ME 712	**HUMAN RESOURCES MANAGEMENT AND ORGANIZATIONAL BEHAVIOR**
Pre-Requisite	NIL
Course Objectives	The HRM & OB focuses on preparing students to impact the study of people, process and outcomes within the fields of organizational behavior and human resources management. Through research, collaboration and dissemination of knowledge, students understand how to impact organizational effectiveness in a variety of different environments, industries and across multiple levels of analyses.
Course Outline	HRM, equal opportunity, job analysis, personnel planning and recruitment, testing, performance management, careers, employees relations, An Overview of the Field of Organizational Behavior, Individual behaviour and learning in organizations, Theories of Employee Motivation and Rewards Systems, Communications in Organizations, Group Dynamics, Teambuilding and Decision Making, Organizational Conflict & Resolution Strategies, Organizational Change and Development, Organizational Culture,Organizationl Structure and Design
Recommended Books	1. Human Resource Management (10th Edition) by Gary Dessler. 2. Human Resources Management by Wendell L. Frencch. 3. Organizational Behavior and Management by John M. Ivancevich, Robert, Micheal, Matteson. 4. Designing the Purposeful Organization: How to Inspire Business Performance Beyond Boundaries by Clive Wilson.

ME 713	**MEMS and Micromachining**
Pre-Requisite	NIL
Course Outline	MEMS devices: MEMS operating principle (electrostatic, piezoresistive, thermal), applications, accelerometers/combdrive, RF switch, micromirror. Design: Scaling issues, system-level design (behavioral modeling) using SPICE, 2D layout design (L-Edit Layout tool, design rule checking, and design verification), 3D modeling with process emulation, physical level simulation and analysis (Finite Element Analysis) using ANSYS. Micromachining (micro-fabrication) technologies: Micromachining techniques (deposit, etch, photolithography), CMOS compatible bulk micromachining, surface micromachining.

ME 801	Advanced Stress Analysis (3+0)
Pre-Requisite	nil
Course Objectives	Strss analysis using tensor theory Experimental and FEA stress analysis Integration of analyitical and, FEA and Experimental stress analysis techniques
Course Outline	Introduction: Analysis of stress and strain, Review of relation for various type of stresses, Equations of equilibrium, Boundary conditions and principal stresses. Generalized Hook's law, boundary value problems of linear elasticity, elasticity applications; Thick tube, Stress concentration due to a Circular hole in a stress plate, concentrated load acting on the vortex of a Wedge and Concentrated force acting on the inadequacies of conventional design concepts. Type of fractures that occur under uni-axial tensile loading. The physical significance of fracture toughness. The role of dislocations in plastic deformation of single and polycrystalline materials, Contact 'Thermal Stresses: Application of Contact Stresses to mating of gear teeth, shaft in a bearing and ball and rollers in bearings. Thermal stresses and thermal strains; applications to turbines and pipes carrying hot fluids. Visco-elasticity Analysis: Type of time dependence superposition, Boltzmann's integral, Differential form, in phase and out of phase components. Laplace transforms and relationship between Viscoelastic parameters. Model materials, Maxwell Voigt and standard linear solid. Photo elasticity. Plasticity: Plane strain deformation and slip line field. Stress distribution from the slip line field. Upper bound and lower bound theorem.
Recommended Books	1. AdvancedStrength and Applied Stress Analysis, R. G. Budynas, McGraw-Hill (1998) 2. A.C. Ugural and S.K. Fenster, Advanced Strength and Applied Elasticity, Fourth Edition, Prentice Hall, 2003

ME 802	**continuum mechanics (3+0)**
Pre-Requisite	Nil
Course Objectives	To provide advanced treatment of the fundamental, unifying concepts of the mechanics of continua in order to facilitate further study in specialized fields such as aerodynamics, mechanics of viscous fluids, elasticity, plasticity, and continuum damage mechanics.
Course Outline	Fundamentals of Cartesian Tensors, Tensor Derivatives, Green-Gauss Theorem. Definition of Strain, Eulerian and Lagrangian Coordinate Systems, Polar Decomposition Theorem, Rate of Deformation, Principal Strain, and Linear Compatibility Equations. Definition of Stress, Cauchy and Nominal Stresses; Balance Laws: Mass, Linear and Angular Momentum, Energy; Principal stresses, Deviatoric and Hydrostatic Stress; Reynolds Transport Theorem, Singular Surfaces in a Continuum. First and Second Laws of Thermodynamics for a Continuum; Equations of State; Coupled Thermomechanics; Boundary Conditions; Fundamental Restrictions on Constitutive Laws (Equipresence,

	Local Action, Objectivity, etc.). Fundamentals of Linear Elastic Behavior of Solids, Material Symmetries, Variational Principals. Fundamentals of Continuum Damage Mechanics using Internal State Variables. Fundamentals of Newtonian Fluids, Inviscid and Viscous Compressible Flow; Navier-Stokes Equations, Ideal and Rotational Flows. Fundamentals of Non-Newtonian Fluids.
Recommended Books	G. Thomas Mase, Ronald E. Smelser, George E. Mase, Continuum Mechanics for Engineers, 3rd Ed., CRC Press, Taylor and Francis Group, ISBN 978-1-4200-8538-9

ME 803	**SPECIAL TOPICS IN DESIGN ENGINEERING**	3(3+0)
Pre-Requisite		
Course Objectives		
Course Outline		
Recommended Books		

ME 804	**MODAL ANALYSIS**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	• To give an understanding of Modal Testing, its possibilities, limitations and to perform proper mobility measurements as the basis for modal analysis • To explain and demonstrate how to plan and execute a complete modal test and to perform modal analysis on real structures	
Course Outline	Introduction, Application and philosophy of modal testing, Summary of theory, Measurement methods, Analysis and test procedures, Introduction to mobility measurement techniques, Basis measurement system structure preparation, Excitation of structure, Transducer and amplifiers, Analyzers, Digital signal processing, Use of different excitation types, Calibration, Mass cancellation, Rotational mobility measurement, Measurement on non-linear structure, Multi excitation methods, Introduction to model parameters extraction methods, Preliminary checks of PRF data, SDOF modal analysis, I peak amplitude, SDOF modal analysis-II, Circle fit method, SDOF Modal analysis-III inverse method, MDOF curve-fitting procedures, MDOF curve –fitting in the same domain, Global or multi curve-fitting, Non-linear systems. Introduction to derivation mathematical models, modal models, Display of modal model, Response models, Spatial models, Mobility skeletons and system models. Applications, comparison of experiment and prediction, correction of adjustment of models, Structure modifications; Coupled structure analysis, Response prediction modifications, Coupled structure analysis, Response prediction and force determination.	
Recommended Books	1. Modal Analysis By D. J. Ewins, Wiley. 2. Modal Testing, Theory and Practice By D. J. Ewins, Wiley.	
ME 805	**ADVANCED AUTOMATIC CONTROL SYSTEMS**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	• *To develop an understanding of the principles of control and optimisation in*	

	industry; • *To analyse the system response and stability in terms of root locus and frequency response techniques;* *To apply these principles to technological and commercial systems including the selection and application of hardware and software for a variety of process plants.*	
Course Outline	Mechanical Systems, representation of Control Systems, z-Transform, State-Space response, Digital Control System, Frequency Response Methods, Controllability and absorbability, Design of observers, Stochastic Analysis of Control System, error Analysis, stability, Lyapunov's stability criterion, Modeling of Control using MATLIB	
Recommended Books	1. Adaptive control systems: techniques and applications, Vol 39 of electrical engineering and electronics, electrical and computer engineering, VV Chalam, CRC Press 1987	
ME 806	**SPECIAL TOPICS IN DYNAMICS AND CONTROL**	3(3+0)
Pre-Requisite		
Course Objectives		
Course Outline		
Recommended Books		

ME 807	**SPECIAL TOPICS IN THERMODYNAMICS**	3(3+0)
ME 808	**SPECIAL TOPICS IN FLUID MECHANICS**	3(3+0)
ME 809	**ADVANCED HEAT TRANSFER**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	• To demonstrate and in-depth understanding of fundamental heat transfer principles • To develop analytic solutions of simplified heat transfer problems	
Course Outline	**Conduction:** Review of analytical methods in heat conduction, melting and freezing, sources and sinks, anisotropic and composites media, numerical methods for steady and unsteady state problems. Numerical methods for solution of steady and unsteady state conduction problems. **Convection:** Analysis of isothermal and non-isothermal boundary layers. Exact and approximate solution of laminar and turbulent flow, variable property and high speed effect, the dimensional analysis. Navier-Stokes equations numerical solutions by velocity and temperature fields in boundary layers of simple and complex shapes. **Radiation** Heat Transfer: Radiation properties; black body radiation, shape factor of radiations, network analogy, and solar radiation.	
Recommended Books	1. Heat Transfer: Textbook by John H. Lienhard. **2.** Heat and Mass Transfer, by Frank P. Incropera.	
ME 810	**SPECIAL TOPICS IN MECHANICAL POWER ENGINEERING**	3(3+0)

Pre-Requisite	
Course Objectives	
Course Outline	
Recommended Books	

ME 811	**ADVANCED CAD/CAM**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	• To develop understanding of the principles underlying computer aided tools used in engineering • To develop students' awareness in the application of CAD and CAM systems in the context of developing engineering products	
Course Outline	Overview of existing CAE systems. Fundamental of CAD: Introduction, Design Process, Creating manufacturing database. CAD/CAM System Hardware Structure, Configuration, Mini, Micro, Interactive display devices, Peripherals, Storage, Display and operating system. Geometric Modal and Technique, Solid Modeling, Graphics in CAD. Conventional numerical control, NC part programming, computer numerical control, NC programming with interactive graphics, The role of group technology in CAD/CAM, The role of process planning in CAD/CAM, Process planning system.	
Recommended Books	1. V. B. Anand: Computer Graphics and Geometric Modeling for Engineers, John Wiley and Sons, 1993. 2. H. B. Kief and T. F. Waters: "Computer Numerical Control", A CNC Reference Guide, GLECOE, discovery. McGraw-Hill, 1992.	
ME 812	**COMPUTER INTEGRATED MANUFACTURING**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	• To develop the concepts of Computer Integrated Manufacturing, Flexible Manufacturing System and automated flow • To develop understanding of classical and state-of-the-art production systems, control systems, management technology, cost systems, and evaluation techniques	
Course Outline	Fundamental of operations and automation strategies, High volume production systems, computer aided manufacturing, numerical Control of Production Systems, Industrial Robots, Material Handling and Storage, Group Technology, Flexible Manufacturing Systems, Quality Control and Automated Inspection, Expert Systems. **Manufacturing Systems**: Introduction, Overview of manufacturing processes, Machine tool and manufacturing equipment, process planning, design of manufacturing system, operation of manufacturing systems.	
Recommended Books	Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Prentice Hall, 2007.	
ME 813	**SIMULATION MODILING OF MANUFACTURING SYSTEMS**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	The objective of this course is to provide an insight into how simulation modeling can aid in effective decision-making.	
Course Outline	System - ways to analyze the system - Model - types of models - Simulation - Definition - Types of	

	simulation models - steps involved in simulation - Advantages & Disadvantages. Parameter estimation - estimator - properties - estimate - point estimate - confidence interval estimates - independent - dependent -hypothesis - types of hypothesis- step - types l& 2 errors - Framing - string law of large numbers. Building of Simulation model validation - verification - credibility - their timing - principles of valid simulation Modeling - Techniques for verification - statistical procedures for developing credible model. Modeling of stochastic input elements - importance - various procedures - theoretical distribution - continuous – discrete their suitability in modeling. Generation of random variables - factors for selection methods - inverse transform - composition - convolution - acceptance - rejection - generation of random variables - exponential - uniform - weibull - normal Bernoullie - Binomial uniform - poisson - Simulation languages - comparison of simulation languages with general purpose languages Simulation languages vs Simulators - software features - statistical capabilities - G P S S - S1MAN- SIMSCRIPT - Simulation of WMJI queue - comparison of simulation languages. Output data analysis - Types of Simulation w. r. t output data analysis – warm up period- Welch algorithm - Approaches for Steady - State Analysis - replication - Batch means methods - corn pan Sons.Applications of Simulation - flow shop system - job shop system - M/MI1 queues with infinite and finite capacities - Simple fixed period inventory system – News boy paper problem.Introduction to Simulation, Basics of Queueing Theory, Queueing Theory vs. Simulation, Kinds of Simulation, First Simio Models, Intermediate Modeling With Simio, Input Analysis, Working With Model Data, Animation and Entity Movement, Advanced Modeling With Simio, Customizing and Extending Simio, Case Studies Using Simio	
Recommended Books	1. Simulation Modelling and Analysis / Law, A.M.&Kelton / McGraw Hill, Edition/ New York, 1991. 2. Discrete Event System Simulation *I* Banks J. & Carson J.S., PH *I* Englewood Cliffs N/ 1984. 3. Simulation of Manufacturing Systems / Carrie A. / Wiley, NY, 1990. 4. A Course in Simulation / Ross, S.M., McMillan, NY, 1990.	
ME 814	**STATISTICAL QUALITY CONTROL AND ASSURANCE**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	This course is at the interface between statistics and quality improvement. Getting the most out of the course requires an understanding of the basic terminology of both fields. Quality Assurance from the viewpoint of Producer and Consumer. Much of this philosophy is credited to Taguchi. Quality systems, philosophy, history and practice. To provide a working framework within modern quality techniques.	
Course Outline	Statistical Process Control, Acceptance Sampling, Design of Experiments, Process average and process variation, Attributes and variables data, Graphical methods, Control charts, Experimental design, Acceptance sampling	
Recommended Books	1. Quality Assurance and Quality Control in the Analytical Chemical Laboratory: A Practical Approach, PiotrKonieczka, JacekNamiesnik. 2. Statistical Methods of Quality Assurance by Hans-Joachim. Mittag, Horst Rinne	
ME 815	**COMPUTER AIDED PROCESS PLANNING**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	Computer-aided process planning is a link between design and manufacturing in a computer-integrated manufacturing (CIM) environment. Commonly used by manufacturing engineers, CAPP can be used to develop a product manufacturing pla n based on projected variables such as cost, lead times, equipment availability, production volumes, potential material substitution routings and testing requirements.	
Course Outline	The process-planning problem as a rigid hierarchical structure of tasks	

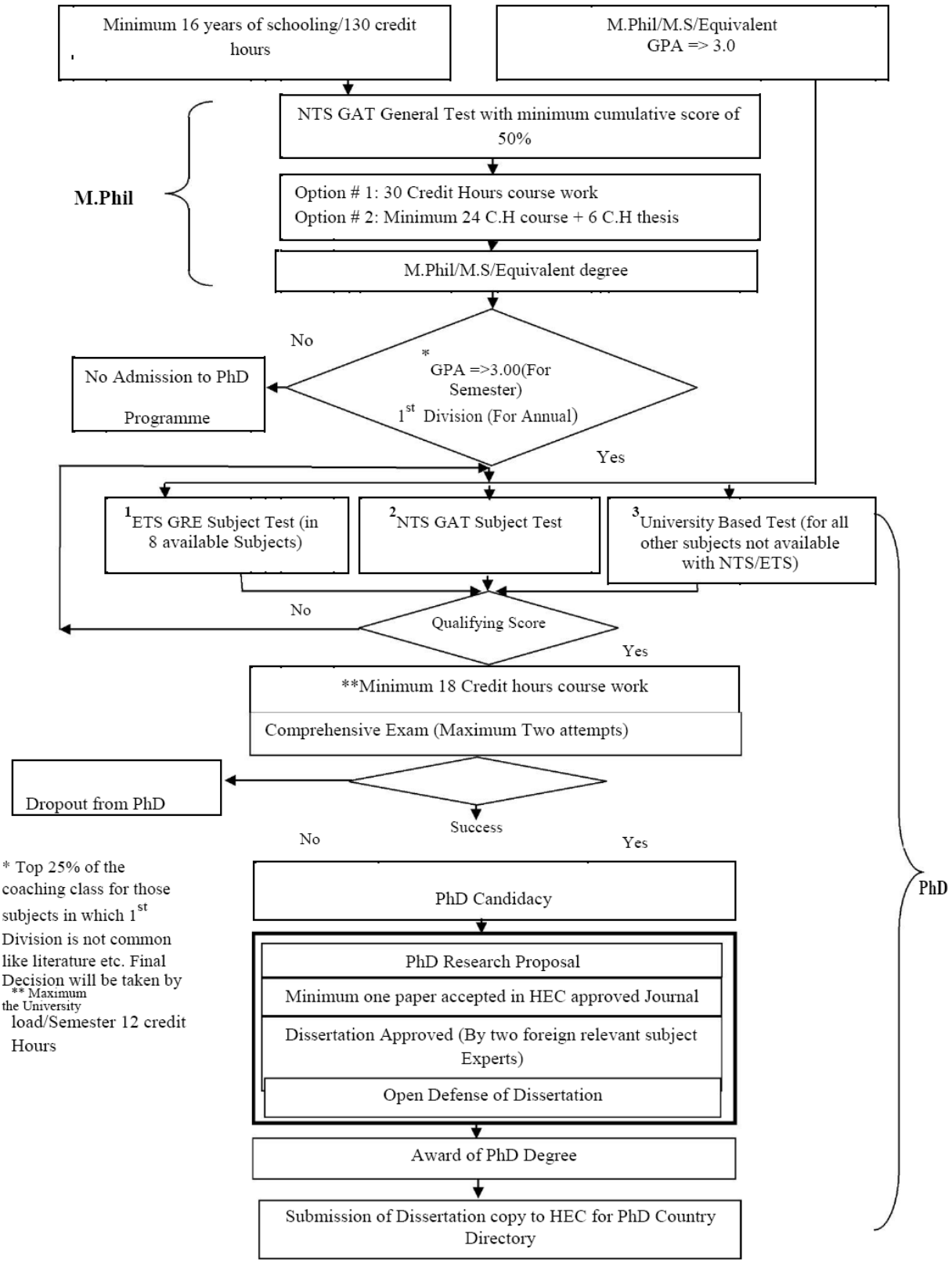
	Determination of machine and cutting parameters, Control, coordinate and manage the entire system. Coordination coupled with decision-making situation. The complexity of CIM systems with hierarchical structures Assimilating a large array of knowledge sources to plan the activities. Computer Aided Process Planning The variant CAPP method, The generative CAPP method
Recommended Books	1.Computer aided process planning by Joseph TulkoffS 2. Computer aided process planning by Architecture Technology Corporation
ME 816	**SPECIAL TOPICS IN MANUFACTURING ENGINEERING** 3(3+0)
Pre-Requisite	
Course Objectives	
Course Outline	
Recommended Books	

ME 817	**Supply chain management** 3(3+0)
Pre-Requisite	nil
Course Objectives	Analyze total system costs in supply chains Know when and how to use various forecasting techniques• Compute tradeoffs between cost and responsiveness in supply chains• Understand the role of logistics in supply chains• Construct and solve supply chain models in Excel•
Course Outline	Building Blocks of a Supply Chain Networt Performance Measures Decisions in the Supply Chain World Models for Supply Chain Decision-MakingEconomic Order Quantity Models Reorder Point Models Multiechelon Inventory Systems
Recommended Books	• Y. Narahari and S. Biswas. *Supply Chain Management: Models and Decision Making* • Ram Ganeshan and Terry P. Harrison. *An Introduction to Supply Chain Management*

ME 818	**SPECIAL TOPICS IN MANAGEMENT** 3(3+0)
Pre-Requisite	
Course Objectives	
Course Outline	
Recommended Books	

Appendix: Flow Diagram for HEC Minimum Criteria for MS and PhD

Flow Diagram for Minimum Quality Criteria for M.Phil/MS & PhD



Note: These are minimum HEC requirements and universities may make them more stringent.