Revised Scheme of Studies for MS
In
Mechanical Engineering

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

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Scheme of Studies for MS in Mechanical Engineering

Degree
Master of Science in Mechanical Engineering (MSME)

Degree Requirement:

- MSME: Course work of 24 credit hours plus research work of 6 credit hours. (total credit hours=30)

Duration of the Program

- Two years
- Maximum duration: Four years

Pre-requisite for the program

For MSME: B.Sc./BE (Mechanical Engineering/Relevant area of engineering) with minimum CGPA 2.50/4.00 or 60% marks in annual system + University's Admission Test/ Interview

Intake
Twice in a year (Spring & Fall Semester)

Details Courses for MS in Mechanical Engineering

Course guide lines for MSME Students

1. **Compulsory Courses for MSME:**
   i. ME500 Research Methodology
   ii. ME501Advanced Numerical Analysis
2. MSME student will have to study courses worth 24 credit hours.
3. MSME student has to do compulsory research thesis worth 6 credit hours.
4. The roadmap for MSME is given in Table 1.

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 MSME 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
	ME 501	Course-IV, Advanced Numerical Analysis	3	3
	Total Credit Hours		12	**12**
2nd Semester	**Course Code**	**Course Title**	**Lec Hrs.**	**Credit Hours**
	XXXXX	Course-V	3	3
	XXXXX	Course-VI	3	3
	XXXXX	Course-VII	3	3
	ME 500	Course-VIII, Research Methodology	3	3
	Total Credit Hours		**12**	**12**
3rd Semester	**Course Code**	**Course Title**	**LecHrs**	**Credit Hours**
	ME 699	Thesis	3	3
	Total Credit Hours		**3**	**3**
4th Semester	**Course Code**	**Course Title**	**Lec Hrs.**	**Credit Hours**
	ME 699	Thesis	3	3
	Total Credit Hours		**3**	3
	Total Credit Hours of Degree		**30**	**30**

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

List of Courses

MS Courses

S. No	Course Code	Course Title	Credit hours
1	ME500	Research Methodology	3
2	ME501	Advanced Numerical Analysis	3
3	ME502	Statistical Analysis	3
4	ME503	Advanced Engineering Materials	3
5	ME504	Finite Element Analysis	3
6	ME505	Mechanics Of Composite Materials	3
7	ME506	Mechanism Design	3
8	ME507	Condition Monitoring of Rotating Machinery	3
9	ME508	Robotics	3
10	ME509	Computational Fluid Dynamics	3
11	ME510	Propulsion Engineering	3
12	ME511	Nuclear Engineering	3
13	ME512	Advanced Metal Forming	3
14	ME601	Theory Of Elasticity	3
15	ME602	Experimental Stress Analysis	3
16	ME603	Engineering Design Optimization	3
17	ME604	Fracture Mechanics	3
18	ME605	Behavior of Materials under Impact Loading	3
19	ME606	Combustion Engineering	3
20	ME607	Renewable Energy Technology	3
21	ME608	Work design and measurement	3
22	ME609	Product Design And Development	3
23	ME610	Project Management	3
24	ME611	Operations Management	3
25	ME612	Total Quality Management	3
26	ME613	Fatigue of Structures & Materials	3
27	ME614	Advanced Mechanical Vibrations	3
28	ME615	Advanced Fluid Mechanics	3
29	ME616	Advanced Thermodynamics	3
30	ME617	Advanced Heat Transfer	3

Course Outlines

ME 500	**RESEARCH METHODOLOGY**	3(3+0)
Pre-Requisite	Nil	
Course Objective	At the end of this course, the students should be able to: understand some basic concepts of research and its methodologies identify appropriate research topics select and define appropriate research problem and parameters prepare a project proposal (to undertake a project) organize and conduct research (advanced project) in a more appropriate manner write a research report and thesis write a research proposal (grants)	

Course Outline	The meaning of research, Research and academics, Research problems, Types of research, Research process and design, Characteristics of good research and choice of research topic, Components of research proposal, Literature review, Research strategies, Sampling analysis, Data collection, Research ethics, Research access, Data analysis and Report writing
Recommended Books	1. Research Methodology by Rajendar Kumar 2. Research Methodology by P . Sam Daniel, Aroma G. Sam

ME 501	**ADVANCED NUMERICAL ANALYSIS**	3(3+0)
Pre-Requisite	Nil	
Course Objective	**1.** To integrate a discussion of the properties of engineering and physical problems with the discussion of methods by which such problems may be solved numerically **2.** To provide understanding of main sources of numerical errors and the power of numerical methods that minimize these errors	
Course Outline	Introduction: basic ideas, concepts, terminology, elements of a numerical method: differential formulation, solution domain and mesh, discretization, set of algebraic equations, solution algorithm. Preview: choice of numerical mesh, Cartesian, polar-cylindrical, general orthogonal, regular non-orthogonal, arbitrary triangular meshes, discretization, truncation and discretization errors, Newton's method of solving algebraic equation of single variable, Crammer's rule for solving set of equations, round off errors and their estimation. Polynomials and Finite differences: collocation-type polynomials, finite-difference-operator algebra, forms of polynomials, relationship to Taylor series. Finite differences: differences and Differential operators, basic operator relations, relations of first, second and higher order derivatives to difference series, solutions errors. Solution of equation sets: Ill-conditioning, iterative solution methods, Decomposition, Eigen-value problem, system stability, characteristic polynomial, roots, Eigen-values, convergence of solution scheme. Ordinary differential equations: order, methods of solving first order ordinary differential equations, higher order differential equations and their conversion into set of first order ordinary equations. Partial differential equations: variants of partial differential equation, choice of finite-difference formulation and solution algorithm, elliptic, parabolic and hyperbolic equations. Discretization and solution of second order 2-D steady diffusion equation, first order 1-D transient diffusion equation, first order 1-D convection equation, Finite volume approach	
Recommended Books	1. Numerical Analysis by Richard L. Burden, John Douglas Faires, 9th Edition, Cengage Learning, 2010, ISBN: 0538733519, 9780538733519. 2. Applied Numerical Analysis by Curtis F. Gerald, Patrick O. Wheatley, 7th Edition (August 10, 2003), Pearson, ISBN-10: 0321133048, ISBN-13: 978-0321133045	

ME 502	**STATISTICAL ANALYSIS**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	• To introduces the field of statistics and hypothesis testing. • To analyze data – or the information collected when for empirical research	
Course Outline	(1) completely describe a data set (a set of scores) using appropriate descriptive	

	statistics, (2) understand the logic and application of hypothesis testing, (3) interpret a set of descriptive statistics and understand the limitations of each measure, (4) apply the appropriate inferential statistical technique to situations, (5) interpret the results of an inferential test and understand the limitations of each procedure, and (6) compute descriptive and inferential statistics.
Recommended Books	1. Statistical Data Analysis (Oxford Science Publications) by Glen Cowan 1998. 2. An Introduction to Multivariate Statistical Analysis , 2003 by T. W. Anderson

ME 503	**ADVANCED ENGINEERING MATERIALS**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	• To be able to perform design using advanced materials and carry out research on mechanical properties of these materials. • To provide students with the latest developments in material technology and applications of new advanced materials.	
Course Outline	Polymeric Material: High performance fiber, high performance elastomers, high performance coatings, special polymers, moderately high polymers, engineering polymers. Materials development and modification, multilayer and adhesive technology will also be part of this course. Physical and chemical testing of polymers. Fundamentals of polymers: Molecular structure, polymerization processes, morphology of polymer molecules, plasticizers and fillers. Composition and characteristics of principal types of polymers, convention constant rate of elongation test, creep tests, isochronous curves and other forms of data presentation, strain recovery and stress relaxation, anisotropy of properties time-dependence of strength and creep rupture, durability under cyclic loading BS impact tests. Fracture of polymers: Fundamentals of fracture mechanics, application of fracture mechanics to polymers, Kc determinations Kc crack speed curves instability, environmental effects impact testing, application to practical problems. Composites: Composite materials compared with conventional materials, fiber and matrices, composite mechanics, elastic properties, failure processes, failure at notches, notch sensitivity and fracture energy. Fatigue and failure of composite materials. Deterioration of properties owing to environmental conditions, hybrid composite materials, manufacturing the by hand lay-up, preparing specimen for mechanical testing, burn off tests to determine fibre volume fracture.	
Recommended Books	1. Polymeric Materials: Structure, Properties, Applications by G. W. Ehrenstein, HanserVerlag, 2001, ISBN: 1569903107, 9781569903100. 2. Composite Materials: Fatigue and Fracture, edited by Ronald B. Bucinell, 7th Volume, ASTM International, 1998, ISBN: 0803126093, 9780803126091. 3. Composite Materials: Science and Engineering by Krishan Kumar Chawla, Springer, 1987, ISBN: 0387984097, 9780387984094.	

ME 504	**FINITE ELEMENT ANALYSIS**	3(3+0)

Pre-Requisite	NIL
Course Objectives	• To develop comprehensive knowledge in the fundamental mathematical and physical basis of finite element method (FEM). • To develop complete FEM solution strategy for analysis of mechanical/thermo-mechanical systems.
Course Outline	The stiffness method and the plane truss, Integral formulations and variational methods, week boundary value problem, Rayleigh – Ritz method, numerical error and accuracy analysis, Eigen value problem, Two and three Dimensional problems, Plane Elasticity, Bending of plates, beams, nonlinearity sources (material and geometric), techniques for nonlinear analysis, Basic Equations of Thermal Analysis, FEs for thermal analysis, Thermal transients, use of commercial FEA codes. Applications of FEA in the relevant fields of study.
Recommended Books	1. Introduction to Finite Element Method by Frank Stasa, CBS. 2. Finite Element Procedures by Bathe, Prentice Hall. 3. ANSYS Manuals, ANSYS Publication.

ME 505	**MECHANICS OF COMPOSITE MATERIALS**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	• To develop comprehensive knowledge in mechanics of composites • To develop skills for design of composites.	
Course Outline	Introduction to composite materials, classification and characteristics of composite materials, mechanical behavior of composite materials, macro-mechanical behavior of a lamina, Stress Strain relation for anisotropic materials, Engineering constants for orthotropic materials, Stress strain relations for plane stress in orthotropic materials. Invariant properties of an orthotropic lamina, Strength of orthotropic laminas Biaxial strength theories for an orthotropic lamina, Biaxial strength theories for an orthotropic lamina. Micromechanical behavior of a lamina, Micromechanical behavior of a laminate. Classical lamination theory, special cases of laminate stiffness, strength of laminates. Entertainer stresses. Design of laminates. Bending, buckling and vibration of laminate plate.	
Recommended Books	Analysis and Performance of Fibre Composites, by Agarwal and Broutman, 2ndEd, John Wiley, NY, 1980	

ME 506	**MECHANISM DESIGN**	3(3+0)
Pre-Requisite	Nil	
Course Objectives	To understand kinematics an dynamics of mechanisms To analyze mechanisms	
Course Outline	Kinematics and dynamic characteristics of planar and spatial mechanisms, Vector and graphical methods for kinematics analysis, Introduction to graphical and computer methods for kinematics synthesis of mechanisms, Methods for dynamic analysis of mechanisms, Applications from industrial machine systems and robotics manipulators.	

Recommended Books	*Mechanism design: enumeration of kinematic structures according to function, Lung-Wen Tsai, CRC press 2001*

ME507	**CONDITION MONITORING OF ROTATING MACHINERY**	3(3+0)
Pre-Requisite	Nil	
Course Objectives	To understand the basics of rotator machinery vibrations To develop skills for the monitoring and maintenance of rotating machinery	
Course Outline	Introduction to basic concepts of machine condition monitoring, conditions based maintenance techniques in industry, predictive analysis, diagnostic analysis, Major benefits of a conditions monitoring program. Practical machine condition monitoring systems in industry, vibration monitoring wear debris monitoring, temperature monitoring, noise monitoring, performance monitoring, data accusation methods, Data analysis techniques, Data interpretations and diagl1liStics, Instrumentation required. Computer aided machine condition monitoring, Use of rotor dynamic simulation as an aid to fault diagnostics, Intelligent knowledge based expert systems for continuous machine surveillance in advanced condition monitoring. Selection and installation of a Machine condition monitoring system, Analysis of the problem measurable parameters, System requirement, Economic considerations in the selection and installation of a machine condition monitoring system, case studies.	
Recommended Books	*Rotating machinery vibration: from analysis to trouble shooting, ML Adams, CRC* *press, 2001* *Vibratory condition monitoring of machines, JS Rao, CRC press, 2000* ME **Mechanics of Micro Structure** 3 Credits	
ME 508	**ROBOTICS**	3(3+0)
Pre-Requisite:	NIL	
Course Objectives	• To familiarize the students with the concepts and techniques in robot manipulator control, to incorporate robots in engineering systems. • To impart fundamentals of manipulators, sensors, actuators, end effectors and product design for automation.	
Course Outline:	An overview of Robotics, Drive methods, Sensors for robots. Spatial description and transformation, Forward kinematics Inverse Kinematics Jacobean, Denavit-Hartenherg coordinate transformations, Force/Torque relations, Trajectory planning, Dynamics, Lagrange equations, Position control, PID control, Inverse dynamics feed forward control, Nonlinear and two parts control. open-Loop Manipulators, Closed Loop Linkages, Epicyclical Gear Drives, Wrist Mechanisms, Tendon Driven Robotics Hands. Robot Sensors including contact sensors and proximity sensors, Machine vision systems Robotics application growth and cost.	
Recommended Books	1. Robotics: Modeling, Planning and Control *Advanced Textbooks in Control and Signal Processing*, by Lorenzo Sciavicco, Springer, 2009, ISSN 1439-2232, ISBN: 1846286417, 9781846286414. 2. Springer Handbook of Robotics *Gale virtual reference library, edited by* Bruno Siciliano, OussamaKhatib, Springer, 2008, ISBN: 354023957X, 9783540239574. 3. Introduction to Robotics: Mechanics and Control By John J. Craig, Prentice Hall; 3rd Edition (August 6, 2004), ISBN-10: 0201543613, ISBN-13: 978-	

	0201543612.

ME509	COMPUTATIONAL FLUID DYNAMICS	3(3+0)
Pre-Requisite	**nil**	
Course Objectives	To understand numerical methods to model fluid flow behaviour	
Course Outline	Introduction; partial differential equation; Basics of finite-difference methods; Concepts of error, consistency and stability; Momentum and energy equations; Diffusion equations; Turbulence modeling; Boundary layer computational methods;	
Recommended Books	*Computational Fluid Mechanics and Heat Transfer by Anderson, Tanehill, & Fletcher, Hemisphere Pub, NY 1984*	
ME510	**PROPULSION ENGINEERING**	3(3+0)
Pre-Requisite	*nil*	
Course Objectives	The objectives of this course are to develop an understanding of how air-breathing engines and chemical rockets produce thrust; an ability to do overall engine performance analysis calculations; an ability to carry out performance calculations for individual engine components; an ability to carry out performance analysis for chemical rockets; an understanding of elementary overall engine design considerations.	
Course Outline	Dynamics and thermodynamics of perfect gases, Quasi-one-dimensional flow, thrust and efficiencies, Aircraft jet engines, propellers, ramjets, Subsonic inlets, supersonic inlets, Turbojets, turbofans, turboprops, Engine performance, engine and aircraft matching, Engine performance, engine and aircraft matching, Chemical rockets, thrust chambers, nozzles, Liquid and solid propellant engines	
Recommended Books	P.G. Hill and C. R. Peterson, *Mechanics and Thermodynamics of Propulsion*, Addison Wesley, 2nd Edition, 1992.	
ME511	**NUCLEAR ENGINEERING**	3(3+0)
Course Objectives	To understand basic of nuclear power To classify, design and maintain nuclear power plants	
Course Outline	**Nuclear structure**; Nuclear stability; Binding energy and mass - energy equivalence; Radioactivity (natural and artificial); Decay rate; Mean life and half life; Radioactive equilibrium; Nuclear Reactions; Q value; Fission reaction; Elastic and inelastic scattering, Neutron reaction; Neutron flux; Cross section for scattering, absorption and fission; Neutron diffusion Neutron leakage; Solution of diffusion equation for a bare reactor; Albedo and reflector saving, Neutron slowing down; Continuous slowing down model' Lethargy; Slowing down power; Moderation ratio, Fermi age. Types of **Nuclear Reactors** Introduction, Pressurized Water Reactor (PWR), and Primary Loop, Pressurize, Chemical Shim Control A PWR Power plant, Boiling Water Reactor (BWR), and Load Following Control, Current BWR System High Temperature Gas Cooled Reactor (HTGR), Advanced Gas Cooled Reactors (AGR). Fast Breeder Reactor and Power plants Introduction, Nuclear Reactions, Conversion and Breeding, Liquid Metal Fast Breeder Reactor (LMFBR) Plant arrangements, LMFBR, Gas Cooled Fast Breeder Reactor (GCFBR).Reactor Materials Choice of a moderator; the fuel; the coolant; Nuclear fuels	
Recommended Books	Nuclear Power Plants by MM Elwakil	

ME 512	ADVANCED METAL FORMING	3(3+0)

Pre-Requisite	NIL
Course Objectives	• To provide student with the understanding of mechanics & various materials widely used in metal forming processes. • To develop ability evaluating the basic design methodologies for metal forming contents.
Course Outline	Macroscopic Plasticity & Yield Criteria: Tresca, & Von Mises criterion; Plastic work, Effective stress; Effective strain; Flow rules for plastic stress – strain relations; Principle of normality. Work hardening & Plastic instability: Tensile test; Mechanical properties; Nominal and true stress-strain curves; work hardening expression; Behavior after necking; Direct compression; Bulge test; Plane-strain compression test. General approach to instability; Balanced biaxial tensin; Thin-walled sphere internal pressure; significance of instability. Strain Rae and Temperature: Strain rate; Super plasticity; combined stress and strain-rate effects; Strain rate dependence; Temperature dependence of flow stress; Hot working; temperature rise during deformation. Ideal Work: Ideal Work or uniform energy; Extrusion & rod drawing; Friction; Redundant work, and mechanical efficiency; Maximum drawing reduction. Slab analysis: Sheet drawing; Comparison of slab method & ideal work method; wire drawing; Direct compression in plane strain; Average pressure during plane-strain compression; Sticking friction; Axisymmetric compression; Flat rolling. Bending: Spring back in sheet bending; Bending with superimposed tension; Sheet bend ability; Bending of sheets & tubes; Forming limits in shape bending. Cupping, Redrawing, and Ironing Cup drawing; Effects of work hardening; Deformation efficiency; Effects of tooling; Redrawing; Ironing. Complex Stamping: Localized necking in biaxial stretching; Formability; Formain limit diagrams; Cupping test; Edge cracking; Bulk forming tests.
Recommended Books	1. Metal Forming Mechanics and Metallurgy by William F. Hosford and Robert M. Caddell. 2. Theory of Plasticity by J. Lubli 3. Mechanical Metallurgy by Dieter
Recommended Books	1. CAD/CAM by McMohen& Brownie. 2. Product Design & Development by Ulrich Eppinger 3. Total Design by Pugh.

ME 601	**THEORY OF ELASTICITY**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	• To develop concepts related to theory of elasticity and methods of solving the problems. • To apply the methods of theory of elasticity in technical calculations on the basis of illustrative examples.	
Course Outline	Cartesian Tensor Analysis, 3D state of stress and stress transformation, Principal stresses and planes. Mohr's Representation, Stress small deformation theory, Strain displacement relations, Strain compatibility equations. Stress-Strain relation, Lame's and engineering constants. Formulating of problem in elasticity, Bi-harmonic equation, Stress function. Plane stress and plane strain problem in Cartesian and polar coordinates. Principle of superposition, Uniqueness of elasticity solution, Axisymmertic plane problems. Semi inverse method. General solution of torsion problem. Solution derived from equations of boundaries. Approximate solution of torsion of cell sections, Review of the	

	equations of the theory of elasticity.	
Recommended Books	1. Theory of Elasticity by S. P. Timoshenko and Goodier, McGraw- Hill. 2. Elasticity, Tensor and Dyadic Approach by Pe-Chi-Chou, John Wiley. 3. Advance Mechanics of Material by Hugh Ford, McGraw-Hill.	
ME 602	**EXPERIMENTAL STRESS ANALYSIS**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	• To learn the basics of commonly used Experimental Stress analysis techniques. • To train students in the modern methods of measuring strains (stresses), displacements, etc.	
Course Outline	Revision of Fundamental concepts of stress and strain in two and three dimensional. Mechanical and electrical gauges. Electrical resistance strain gage material, Foil and wire gages, Two and three elements rosette, Cross sensitivity factor, Potentiometer and Wheatstone bridge circuit, Full-half and quarter bridge circuit, Strain indicators, Data acquisition systems, Transducers. Optics description of light as an electromagnetic wave. Maxwell's equations. Design of optical elements. Wave plates. Theory of diffraction of light, Stress optic law, Photo-elasticity. Caustics. Stress Freezing, Scattered ray and brittle coating techniques. Grid methods. Brittle coatings. Laser interferometry. Moire interferometry. Normal and transverse displacement interferometers. Mechanical testing of ductile and brittle materials. Quasi-static loading, Dynamic loading.	
Recommended Books	1. Experimental Stress Analysis by J. W. Dally and W. F. Riley. 2. Handbook on Experimental Mechanics. Edited by Albert S. Kobayashi.	
ME 603	**ENGINEERING DESIGN OPTIMIZATION**	3(3+0)
Pre-Requisite:	NIL	
Course Objectives	• To provide knowledge about traditional optimization techniques and newer techniques for multidisciplinary optimization. • To develop ability for proper engineering optimization problem statement and select which method is appropriate for a given application.	
Course Outline:	Modeling. Mathematical modal. Nature of design process. Analysis and design models. Optimal design. Formal optimization model. Bounded ness, Feasibility and constraint activity. Topography of the design space. Mathematical review. Notation. Multi-variable functions. Continuity gradient and definite matrices. Convergence of algorithms. Conditions of optimality: necessary and sufficient conditions for unconstrained and constrained optima. Meeting of LaGrange multipliers. Methods of unconstrained optima. One dimensional minimization. Bisection and golden section initial bracketing, Polynomial interpolation. Multi-dimensional minimization. Steepest descent. Conjugate direction & conjugate gradient methods. Newton's method and its modifications. Quasi-Newton methods. Scaling. Stopping criteria. Methods for constrained optima. Interior and exterior penalty method. Augmented lagrangian method. Direct methods.	
Recommended Books	1. Principles of Optimal Design by Papalambros& Press, USA. Wilde, McGraw-Hill 2. Introduction To Optimum Design by J. Arora,	
ME 604	**FRACTURE MECHANICS**	3(3+0)
Pre-Requisite	NIL	

Course Objectives	• To calculate the stress-strain and load-displacement fields around a crack tip. • Identify and formulate stress intensity factor, strain energy release rate, and the stress and strain fields around a crack tip for linear and non linear materials. • To define and predict fracture toughness of materials and be familiar with the experimental methods to determine the fracture toughness, and • To design materials and structures using fracture mechanics approaches.
Course Outline	Introduction to fracture mechanics. Types of cracks. Fracture toughness, stress intensity factors. Crack opening modes. Singular stress fields, Crack tip stress fields. Ductile to brittle transition. Linear elastic and elastic-plastic fracture mechanics, J-integral, Post yield fracture mechanics, Failure theories. Fracture mechanics in design, experimental and analytical procedure in fracture mechanics. Case studies: ships, aerospace, and nuclear reactors
ME 605	**BEHAVIOR OF MATERIALS UNDER IMPACT LOADING** 3(3+0)
Pre-Requisite	Nil
Course Objectives	To understand impact phenomenon To design against impact loading
Course Outline	Stress waves: Propagation of elastic waves in continuum. Wave Reflections and interaction. Solution of wave equation by method of characteristics. Experimental techniques, diagnostic tools: Laser interferometry, rotating cameras. Experimental techniques for impact loading hopkinsion bar, kolsky bar, fracture Bar, gas gun. Material behavior under high strain rates: Steel, Aluminum alloys, MMCs, Plastics. Dynamic Fracture: Fracture Mechanics, Limiting Crack Speed. Crack Branching. Stress wave loading of cracks. Spalling. Fragmentation. Dynamic fracture of steels, Aluminum alloys, Plastics. Applications: introduction. Shaped charges and projectiles. Penetration. Armor. Dynamic Effects in Geological Materials. Dynamic Events in Space.

ME 606	**COMBUSTION ENGINEERING** 3(3+0)
Pre-Requisite	NIL
Course Objectives	To understand the fundamental relationships between mass, moles, energy forms, and temperature To understandthe basics of combustion kinetics and mechanisms
Course Outline	Combustion thermodynamics, introduction to chemical kinetics of combustion, combustion properties of fuels, flammability of combustible mixtures. Flame propagation mechanisms, pre-mixed and diffusional; stability of flames; introduction to combustion aerodynamics, jet flames; atomization; droplet and spray combustion. Elementary ignition concepts and theory. Basic detonation theory.
Recommended	*1. Combustion: physical and chemical fundamentals, modeling and simulation,*

Books	*experiements, pollutant formation, J Warnatz, Ulrich Maas and Robert W Dibble, fourth ed., Springer, 2006* *2. Combustion, Irvin Glassman and Richard A Yetter, fourth ed., Academic press, 2008*	
ME 607	**RENEWABLE ENERGY TECHNOLOGY**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	The main purpose of this course is to introduce students to renewable energy resources availability, potential and deplorability as a substitute for conventional energy resources in future energy demand.	
Course Outline	Introduction to conventional and Renewable energy sources environmental impacts, challenges and future trends, fundamentals, potential, estimation and, applications, Solar Energy, Wind Energy, Hydropower, Biomass, Geothermal Energy, Ocean Energy	
Recommended Books	--	

ME 608	**WORK DESIGN AND MEASUREMENT**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	To calculate the time that a task or set of tasks should take to be performed. To apply predetermined time values to activities from memory or from a data card according to the rules of BasicMOST work measurement system. To observe operator activities and write accurate method descriptions using the work measurement system.	
Course Outline	Understand the foundation of work measurement, Learn why work measurement is important to an organization.Learn about the traditional work measurement techniques of time study and predetermined motion time systems.Application courses designed to teach and provide practice in completing sequence models.Video courses designed to guide the participant through the complete process of identifying objects and measuring work with MOST. Learn the four basic sequence models used in the BasicMOST work measurement system, General Move – work measurement sequence model for the movement of an object freely through the air.Controlled Move – work measurement sequence model for the movement of an object while it remains in contact with a surface or is attached to another object during movement.Tool Use – work measurement sequence model for the use of common hand tools.Equipment Use - sequence model for various administrative activities.	
Recommended Books	**1**. Motion and Time Study: Design and Measurement, by Ralph M. Barnes 2. Work Measurement and Methods Improvement, by Lawrence S. Aft	

ME 609	**PRODUCT DESIGN AND DEVELOPMENT**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	To learn methods of reducing development costs and time necessary for commercialization. To enable students to co-ordinate and schedule the activities involved in the	

	design and development of products within the entire set of activities, taking into account time, tasks, resources and manufacturing.
Course Outline	Design process, advanced technology for design process, idea generation and creative problem solving, Project-centered subject addressing transformation of new ideas into technology based products, attaining a proper match between product and marketplace. Product design specification, Product design issues: evaluation, market perception, aesthetics and human interfacing, Design for manufacturability, reliability, and repair ability, pricing and legal implications.

ME 610	**PROJECT MANAGEMNT**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	To understand the concepts of project definition, life cycle, and systems approach; To develop competency in project scooping, work definition, and work breakdown structure (WBS); To handle the complex tasks of time estimation and project scheduling, including PERT and CPM	
Course Outline	Project management growth: concepts and, definitions, organizational structures, organizing and staffing the project office and team, management functions, planning, network scheduling techniques, project graphics, pricing and estimating, cost control, trade-off analysis in a project environment, risk management	
Recommended Books	1. Project Management Institute (PMI). A Guide to the Project Management of Knowledge (PMBoK). Newton Square, PA. 1996. (Reference) 2. J.R. Meredith and S.J. Mantel. Project Management: A Managerial Approach. John Wiley and Sons. New York. 1995. (Reference). 3. Project Management, A system approach, planning, scheduling and control by Harold Kerzner, Latest Edition	
ME 611	**OPERATIONS MANAGEMENT**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	To provide students with a state-of-the-art overview of operations management. The goal is to teach the fundamental principles of operations and how they relate to making a firm more competitive. Operations Strategy for Competitive Advantage, designing operations, managing operations, and quantitative modules.	
Course Outline	This course covers topics related to operations management such the difference between manufacturing and services organisations, characteristics of operations managers, and the relationship between operations, productivity and competitiveness. This is extremely useful for anyone interested in a career in operations management. Introduction to Operations and Supply Management, Forecasting, Process Design, product/service, process, facility, waiting lines, work, systems and location, Quality Management, Capacity Planning and Inventory Control, - lean manufacturing,, inventory management, material, requirements planning, just-in-time, enterprise resource, planning, scheduling and control, Supply Chain Management	

Recommended Books	1. Operations Management by Barron 2. Operations Management by Jay Heizer, Barry Render-, 10th Edition (2011).	
ME 612	**TOTAL QUALITY MANAGEMENT**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	The course aims to impart knowledge on the quality management process and key quality management activities Demonstrate how to design quality into product and services, describe the importance of developing a strategic plan for Total Quality Management.	
Course Outline	Introduction to TQM, ISO-9000 Quality Model, Quality in manufacturing and service, Principles of total quality management, Leadership and Strategic planning, A focus on the customer, Quality measurement, Method for continuous improvement, Participation and teamwork, Implementation issue and strategies, inspection & quality control. Control Charts and their applications. Economics & quality control, Life testing, reliability, reliability prediction and calculations, reliability enhancing techniques.	
Recommended Books	1. Total Quality Management by James R. Evans, American Management Assoc. 2. Total Quality Management by Johns OrnlandAmriu S. Soha, Pacific Rim.	
ME 613	**FATIGUE OF STRUCTURES & MATERIALS**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	• To give students an applied understanding of the three basic methods of fatigue analysis (stress-life, strain-life, fracture mechanics) for all classes of materials. Emphasis is placed on the engineering experience practice using practical homework problems and short projects.	
Course Outline	Introduction and brief review Historical Overview Macro and Micro Aspects of Fatigue -Fracture surfaces -Fatigue Mechanism Crack nucleation Crack growth Fatigue failure Stress-Life Analysis - S-N Curves - Mean Stress Effects (Goodman, Soderburg, Gerber) - Modifying Factors (Marin) Strain-Life Analysis - Fundamental Material Behaviour - Plasticity Relations - Elastic and Plastic Strain Components - Strain-Reversal Curves Fracture Mechanics (Fatigue Crack Propagation) Analysis - LEFM - Fatigue Crack Growth Curves - Relationships (Paris Power Law, Forman) - Closure Effects, Short Cracks, Stress Raisers Effects of Notches, Variable Loading, Multi-Axial Loading and Other Conditions - Blunt vs Sharp Notches in Brittle and Ductile Materials - Damage Parameters and Combined Loading (Palmgren-Miner, Rainflow) 19.Equivalent Stress and Strain Corrosion & Fretting Fatigue Fatigue and Failure of Joints and Structure Methods to enhance fatigue resistance	
Recommended Books	1. Fundamentals of Metal Fatigue Analysis, by Julie A. Bannantine, Jess, J. Comer, James L. Handrock, Prentice Hall Pub 1990 2. Schijve, J., and T. U. Delft. "Fatigue of Structures and Materials' Kluwer Academic Publishers." PO Box 17: 3300. 3. Stephens, Ralph I., et al. Metal fatigue in engineering. John Wiley & Sons, 2000.	

ME 614	ADVANCED MECHANICAL VIBRATIONS	3(3+0)
Pre-Requisite	NIL	
Course Objectives	• To learn application of analytical and computational methods for machine design and vibration control problems. • To enable students in conducting basic vibration analysis of systems with a large number of degrees of freedom.	
Course Outline	Properties of vibrating system, Lagrange's equation. Continuous systems: Transverse vibration of string of cable, longitudinal. Use of computers for solution of vibration problems. Orthogonality of Eigen vectors, modal matrix, normal mode summation, computational methods, Gauss elimination, matrix iteration to the Finite Element Method, mode summation procedures for continuous systems, random vibrations, non-linear vibrations, perturbation method, phase plan, modal analysis.	
Recommended Books	1. Mechanical Vibrations, S. S. Rao, Prentice Hall, 5th edition. 2. Theory of Vibration with Applications, W. T. Thomson, Prentice Hall, 5th edition. 3. Fundamentals of Mechanical Vibrations, S. G. Kelly, McGraw-Hill, 2nd edition.	
ME 615	**ADVANCED FLUID MECHANICS**	3(3+0)
Pre-Requisite	NIL	
Course Objectives	• To train students to identify, formulate and solve engineering problems concerning internal and external flows. • To formulate the boundary layer problems and momentum integral equation and to obtain the exact solutions or the approximate solutions of the momentum equation.	
Course Outline	Laminar and turbulent boundary layer flow with and without heat transfer, boundary layer separation stability transition and control. Kinematics and dynamics of flow of continuous media, Navier-Stokes equation, simplification, exact and approximate solution. Irrational of hydrodynamics stability, turbulence, free shear flows, chemical reactions, and shock expansion. Rotating Fluid Machinery: Aero dynamics of compressors & turbines, subsonic, transonic and supersonic flow characteristics, secondary flow and stall stability, components matching of total non-dimensional representation of performance.	
Recommended Books	1. William Graebel,*Advanced Fluid Mechanics*, Academic Press 2. K. Muralidhar, GautamBiswas, *Advanced Engineering Fluid Mechanics*, Alpha Science International. **3.** ArvedJaanRaudkivi, Robert A. Callander, *Advanced Fluid Mechanics: An Introduction*, John Wiley & Sons, Incorporated.	
ME 616	**ADVANCED THERMODYNAMICS**	3(3+0)
Pre-Requisite	NIL	
Course Outline	Equilibrium of thermodynamics systems: spontaneous changes, criterion of stability, equilibrium of system. System of constant chemical composition: thermodynamic properties, equation of state, law of corresponding states, relations for pure substance, the third law of thermodynamics, Gibbs free energy equation, heats of reaction or calorific values, adiabatic combustion, heats of formation and Hess's law, entropy of ideal gas mixtures. Gas mixtures of variable composition: chemical potential, stoichiometery and dissociation, chemical equilibrium, equilibrium constant and heat of reaction, Van't Hoff's equation, temperature rise due to combustion reaction, Lighthill ideal dissociating gas, ionization of monatomic gases, non -equilibrium processes, equilibrium and frozen flows.	

Recommended Books	1. Ibrahim Dincer and Marc A. Rosen, Elsevier, *Exergy: Energy, Environment and Sustainable Development*. 2. DE Winterbone, *Advanced thermodynamics for Engineers*, Arnold, 1997. 3. K. Annamalai, I. K. Puri, *Advanced thermodynamics engineering*, CRC Press, 2002. 4. Ibrahim Dincer and Tahir Abdul HussainRatlamwala, *Integrated Absorption Refrigeration Systems: Comparative Energy and Exergy Analyses*, Springer	
ME 617	**ADVANCED HEAT TRANSFERTHERMODYNAMICS**	3(3+0)
Pre-Requisite	NIL	
Course Outline	An advanced study of the transmission of heat by conduction, convection and radiation. Conduction and convection: derivation and application of their equations governing steady and unsteady conduction heat transfer, transient conduction, and numerical solutions are examined with selected topics. Governing equations for forced and natural convection; dimensional analysis and similarity transforms. Radiation: physical properties of radiation, thermal radiation laws, characteristics of real and ideal systems, geometric shape factors, grey and non-grey system analysis, energy transfer in absorbing media and luminous gases, solar radiation.	
Recommended Books	1. Amir Faghri, Yuwen Zhang, John R. Howell, *Advanced Heat and Mass Transfer*	