TECHNICAL ELECTIVE COURSES

ME-423 RENEWABLE ENERGY RESOURCES (3,0)

Specific Objectives:

- To understand exploration of various energy sources.
- To understand the concepts of energy conversion systems
- To implement the ways of energy conservation and management.

Course Outline:

Introduction to types of renewable energy, solar energy, tidal wave and geothermal energy, biomass energy, fuel cell and heat pump systems, energy efficiency issues and energy storage, potential of using renewable energy resources as supplement of conventional energy resources.

Renewable and non-renewable energies used as hybrid energy systems, modern renewable energy plants.

Wind energy, wind turbine design specifications, compatible electric generators and major operational, wind mills design usage for pumping water.

Biomass energy conversion methods, detailed description of synthetic gas, biodiesel, biomass and biogas, operational and maintenance problems and their remedies.

- 1. Renewable Energy, By Godfrey Boyle, Oxford University Press
- 2. Renewable Energy Resources, By john Twidell, Tony Weir, Spon Press
- 3. Renewable Energy Conversion, Transmission and Storage, By Bent Sorensen

ME-412 TRIBOLOGY (3,0)

Specific Objectives:

- To understand the tribological systems:
- To design the interfaces between two or more bodies in relative motion.

Course Outline:

Fundamental topics include: chemical. physical geometric, and characterization of surfaces; friction and wear mechanisms for metals, polymers, and ceramics, including abrasive wear, delamination theory, tool wear, erosive wear, wear of polymers and composites; and boundary lubrication and solid-film lubrication. The course also considers the relationship between nano-tribology and macro-tribology, rolling contacts, tribological problems in magnetic recording and electrical contacts, and monitoring and diagnosis of friction and wear. Case studies are used to illustrate key points.

Recommended Books:

- 1. Engineering Tribology, by G. W. Stachowiak.
- 2. Tribology, Friction and Wear of Engineering Materials by I.M. Hutchings.

ME-413 MAINTENANCE ENGINEERING (3,0)

Specific Objectives:

- To understand the significance of maintenance engineering.
- To understand the concepts of maintenance engineering.
- To implement the ways of maintenance engineering.

Course Outline:

Introductory management aspects concerning engineering maintenance, Maintenance and control, Preventive maintenance (PM), Various aspects of corrective maintenance (CM) maintenance processes, Modern system life cycle. Reliability-centered maintenance, Quality maintenance.

Recommended Books:

1. Maintenance Engineering Handbook by R. K Mobley, L. R. Higgins, D. J. Wikoff, McGraw-Hill

2. Maintenance Engineering & Management by R.C. Mishra, K. Pathak, Prentice Hall of India

3. Engineering Maintenance, A Modern Approach by B. S. Dhillon, CRC Press London

ME-424 COMPUTATIONAL FLUID DYNAMICS (2,1)

Specific Objectives:

- Computational Fluid Dynamics Course provides an introduction to the methods and analysis techniques used in computational solutions of fluid mechanics and heat transfer problems.
- This course introduces the students to the finite difference and finite volume method as a means of solving different type of differential equations that arise in fluid dynamics.

Course Outline:

Introduction to Computational Fluid Dynamics, Problem solving strategy using CFD, Governing Equations of Fluid Flow, Discretization of Governing equations, Finite difference method, Introduction to the Finite Volume Method, Numerical solution of governing equations, Solution analysis and accuracy, Introduction to advanced topics

Recommended Books:

- 1. Jiyuan Tu, Guan Heng Yeoh and Chaoqun LIU, Computational Fluid Dynamics: A Practical Approach, Butterworth-Heinemann/Elsevier.
- 2. J. D. Anderson, Jr., Computational Fluid Dynamics: The Basic with Applications, McGraw-Hill.
- 3. H. Versteeg and W. Malalasekera, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Prentice Hall/Pearson.
- 4. Suhas V. Patankar, Numerical Heat Transfer and Fluid Flow, Taylor & Francis.

ME-425 GAS DYNAMICS (3,0)

Specific Objectives:

- To understand the application of mechanics and thermodynamics to a variety of compressible fluid problems, both practical and theoretical.
- Emphasis is placed on understanding physical mechanisms and the use of computer simulations to understand unsteady compressible flows and pressure waves in fluids.

Course Outline:

Basic governing laws of conservation of mass, momentum and energy, limitations. Sub-sonic and supersonic gas flow. Mach number and Mach angle. Isentropic Flow and Applications; Operation of nozzles under varying pressure ratios. Normal and oblique shocks, Prandtl-Meyer compression and expansion with applications. Rayleigh flow and Fanno flow, Busemann's shock polar diagram.

Recommended Books:

1. Gas Dynamics, By M. J. Zucrow and J. D. Hoffman, Wiley. John Wiley & Sons, 1976

- 2. The Dynamics and Thermodynamics of Compressible Fluid Flow (Volume 1), 1st Edition By A. H. Shapiro, Ronald Wiley
- 3. Gas Dynamics, 2nd Edition By J. E. John, Allyn and Bacon.
- 4. Compressible Flow By B. W. Imrie

ME-426 AERODYNAMICS (3,0)

Specific Objectives:

- To understand the concepts in incompressible airfoil theory, including symmetric and cambered airfoils using analytical and numerical approaches.
- To understand the incompressible wing theory, including down wash, lifting-line theory, elliptic wings, general twisted wings, application of fundamentals to the design of a wing to meet given performance criteria.

Course Outline:

Introduction, aerodynamics of incompressible flow, compressible and ideal fluid flow, airfoils theory, finite wing aerodynamics, blade element theory and aircraft propellers, Cascade aerodynamics, jet propulsion, intake and nozzle performance, aircraft performance measurement.

Recommended Books:

- 1. Aerodynamics for Engineering Students, By El. Houghton & A. E. Brock St Mortin Cambridge University Press, 2003
- 2. Aerodynamics, By L. J. Clancy, Hallstead Pr.

ME 426 HEAT VENTILATING AND AIR CONDITIONING SYSTEM (2,1)

Course Outline:

Introduction, definitions and basic terminology, refrigeration cycle, vapor compression cycle, COP, introduction to pressure- enthalpy chart, types of refrigerants, air cycle refrigeration, vapor absorption refrigeration, Air conditioning, indoor and outdoor air conditions, comfort air-conditions and comfort zone, indoors air quality, psychrometry, psychrometric chart and psychrometric properties, central air-conditioning system, essential components of central air-conditioning plant, water chiller and water heater, air handling unit, chilled water and hot water re-circulating system, return air supply system, fresh air supply system air mixture chamber, supply fan, air dust cleaning and bacteria removal, air supply system and air return terminals, diffusers, dampers, grilles and registers, CFM rating and tons of air-conditioning of central air-conditioning plant, cooling and heating loads, calculation procedures, duct sizing and piping design, pumps and fans selection, air ventilation, calculation of fresh air supply of multi story buildings, air handling units for treatment of fresh and return, dust and bacteria removal methods, forced convection based air ventilator design, cooling towers, hydronic terminal units.

ME-414 FRACTURE MECHANICS (3,0)

Course Outline:

Fatigue and Fracture Analysis of metallic components including welded joints. Review of test and design procedures. Sources of cyclic loading. Cyclic counting procedures and cumulative damage. S-N curves and effects of mean, residual and multiaxial stressing. Stress Concentrations; scatter and fatigue life distributions. Transition temperature concepts. Linear elastic fracture mechanics analysis of fatigue crack propagation and fracture initiation. Crack arrest.

ME-415 MECHANICAL ENGINEERING DESIG ANALYIS: (3,0)

Philosophy and concept of engineering design. Engineering creativity, Phases and procedure in design. Management of engineering project. Computer aided design. Modeling and simulation, Optimization and reliability. Application of industrial design codes. Design for service, Manufacturing, cost. Philosophy of design softwares and analysis.

ME-416 AUTOMATION AND ROBOTICS: (3,0)

Robotics: Basic concepts in robotics, classification and structure of robotic system, drive and control system, coordinate transformation, kinematics dynamic analysis and trajectory interpolation, interfaacing with micro controllers and PLCs, applications of robots. Robotics and Automated Guided Vehicles. Basic robot motion, path control, robot drive system sensors, robot-computer interface, robot programming, Automated Guided Vehicles (AGV) types. Programmeable logic controller (PLC). Basics components and terminologies, ladder diagram elements, relay sequencing, processor input and output modules, programming unit and programming procedures with machines or assembly language. Microcontroller. Basic elements of microcontroller, types of microcontroller, micro processor and PLC, overview of architecture and principles of operations, assembly, machine and high level programming languages for microcontroller, input and out put peripherals for specific application in mechanical engineering with interfacing techniques. Actuators, sensor, input signals, output signals, signal conditioning. Automations: Introduction to automations, automation strategies, economics of automations, partial automations, group technology and flexible manufacturing. Use of sensors and actuators in automations

ME-417 Production Engineering (2,1) Course Outline:

Material Removal. Machines of chips formation, types of chips produced, forces and pressures involved, surface finishing and integrity, machinability. Calculation of material removal rate. Cutting Tools. Single point tool geometry, mill cutters, factors which affect tool life, tool life relationships, tool materials, types and properties of cutting fluids. Machine Processes for Producing Various Shapes. Milling operation, Milling machines, planning and shaping, broaching and broaching machines, gear manufacturing by machining. Abrasive Machining & Finishing Operations. Abrasive, bonded abrasives (grinding wheels), grinding process, grinding fluids, design considerations for grinding, ultrasonic machining.

Non Conventional Machining Process. Machining, electrochemical, electrical – discharge machining, wire E D M Control of Machine Tools. Machine tools control, numerical control

system, sequence control, PLC, servo copying, Computerized Numerical Control.(CNC), adaptive control, programming for numerical control Jigs & Fixtures. General design principle, elements of jig, locating devices and clamping devices. Computer Integrated Manufacturing System. Manufacturing system, Computer Integrated Manufacturing (CIM), Computer Aided Manufacturing (CAM), computer simulation of manufacturing process and system, group technology, Flexible Manufacturing System (FMS), Artificial Intelligence (AI), Cellular manufacturing. Metrology Specification and standardization, limit and fits tolerances and allowances. Precision measurements: Standards; sources of errors, angular measurement, measuring microscope, optical projection straightness and flatness testing, surface finish measurement. Introduction to Process Planning

Lab Outline:

Experiments related to the course outline mentioned above will be covered in the Lab class.

Recommended Books:

- 1. Manufacturing Engineering and Technology 5th Edition By Kalpakjian Prentice Hall
- 2. Process and materials of manufacture By R.A Lindberg
- 3. Principle of Engineering Production 2nd Edition By AJ Lissaman & SJ Martin
- 4. Manufacturing Technology By Hazel Hurst.
- 5. Engineering Metallurgy By R.A Higgins
- 6. Manufacturing Science By Gosh and Malik

ME-418 MODELING AND SIMULATION (2,1)

Basic mathematical tools for kinematics and dynamics modeling of planar and spatial rigid multi body dynamic systems, Absolute and relative kinematic constraints and driving constraints, virtual work and the generalized force concepts, equations of motion for constrained rigid multi body systems, inverse dynamics of kinematically driven systems, equilibrium conditions, and constant reaction forces, Euler parameters for the orientation of rigid bodies in space, numerical considerations in solving spatial differential-algebraic equations of motion, Methods of coordinate transformations with the help of Euler angles, Direction cosines and Quaternion, Attitude dynamics (dynamics of angular motion), Failure mode analysis, Robustness analysis, Monte Carlo Simulations, ANSYS / COMSOL MULTIPHYSICS for analysis

ME-419 ENGINEERING OPTIMIZATION (2,1)

Optimization methods, nonlinear optimization under constraints, multi objective optimization, multidisciplinary design, incorporating different disciplines simultaneously, single and multi-objective optimization under constraints, Different approaches to Multidisciplinary Design

ME-428 Introduction to Nuclear Engineering (3,0) Nuclear Physics Review

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

Reactor Physics

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.

Reactor Theory

Nuclear chain reactors; Criticality; The four factor formula; One group critical equation; The critical size, Non-leakage probability; Neutron life cycle.

Reactor Kinetics

Excess reactivity and reactor-period; Xenon poisoning.

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.

Allied Topics

Nuclear power economics; Fuel reprocessing; Health hazard due to reactions; Shielding; Nuclear applications for peaceful purposes.

ME-431 Finite Element Methods (2,1)

Specific Objectives:

- To understand the mathematical and physical principles underlying the Finite Element Method (FEM) as applied to solid mechanics and thermal analysis
- To understand the importance of analysis and design, using the FEM, in the broader context of engineering practice

Course Outline:

Introduction to stress analysis by FEM, Basic concepts, Types of elements, linear static analysis, Review of the basic continuum theory, 1-D and 2-D FEM problems, Plane stress and plane strain problems, energy method, variational principles and Ritz's methods; co-ordinate transformation; isoparametric formulation, solution of eigen value, boundary value, discretized time dependant problems, use of commercial finite element code, project based learning of FEM.

- 1. An Introduction to the Finite Element Method, J. Reddy, McGraw-Hill.
- 2. The Finite Element Method: Principles and Applications By P. E. Lewis, J. P. Ward. Addison-Wesley Publishing Co. 1991
- Advanced Strength and Applied Stress Analysis 2nd Edition, By Richard G. Budynass, McGraw-Hill

4. Finite Element Analysis-Theory and Application 2nd Edition, By Saeed Moaveni, Prentice Hall

ME-432 CAD/CAM (2,1)

CAD: Fundamentals of CAD, Hardware in CAD, Computer Graphics software and data base, Mathematical elements of CAD, Finite Element analysis.

CAM: Conventional Numerical Control, NC part programming, Computer controls in NC

Recommended Books

1. Automation, Production Systems and Computer Integrated Manufacturing By M.P. Groover, Prentice Hall1987

2. Computer Aided Design and Manufacturing, By M.P. Groover & E.W. Zimmers, Prentice Hall. 1986

3. Computer Integrated Design and Manufacturing By David D. B. Edworth. 1997

4. HTMastering CAD/CAM 1st Edition By Ibrahim ZeidTH McGraw-Hill

ME-429 Power Plant (2,1)

Specific Objectives:

- To gain understanding of working principles of various types of power plants operating on conventional as well as renewable energies
- To learn the methods of trouble shooting, maintenance and optimization of various types of power plants

Course Outline:

Conventional power plants

Steam turbine, gas turbine, combined cycle, jet engine, diesel engine, nuclear, hydroelectric and combined heat and power plants (CHP).

Non-Conventional power plants

Solar, wind, geothermal, ocean waves and tidal power plants.

- 1. Power Plant Technology, By M. M. El Wakil, McGraw-Hill
- 2. Power Plant, By F. T. Morse
- 3. Applied Thermodynamics for Engineering Technologist, By T. D. Eastop & J. McConkey

ME-433 Hydraulics & Pneumatics

Course Outline:

Fluid theory and applied physics which relates to hydraulics. Theory of operation, maintenance requirements, and adjustments of various hydraulics components and systems. Ability to test, inspect, troubleshoot, and service hydraulic systems and overhaul malfunctioning components. Pneumatics as used in aircraft operation. Fluid flow, identifies the various actuating units, types of seals, pumps and differences between hydraulics and pneumatics. The inspection, maintenance and repair of the various components.

ME-434 Introduction to composite Materials

Course Outline:

The concepts covered in this course include:

An introduction to composites materials ,An introduction to tensors, stress, strain and elasticity theory, Elastic behaviour of continuous fibre composites ,Elastic behaviour of short fibre composites ,A description of the nature and importance of interfaces ,Fracture strength of composites ,Fracture toughness of composites ,Thermal behaviour and creep ,Plastic deformation of composite materials, Expanding to other properties of composite materials, New types of composite materials: Functionally Graded and Architectured Materials, Fabrication routes of composite materials.

Recommended Books

An Introduction to Composite Materials, 2nd Edition, by D. Hull and T.W. Clyne, Cambridge University Press (1996).

S. Suresh and A. Mortensen, Fundamentals of Functionally Graded Materials K.K. Chawla, Composite Materials A. Kelly and N. H. MacMillan, Strong Solids

MANAGEMENT ELECTIVE COURSES

MS-401 INDUSTRIAL MANAGEMENT (3,0)

Specific Objectives:

- Optimization of organizational resources
- To understand the tools/techniques related to Project Management
 To develop efficient relations with supplier and customers

Course Outline:

Plant management

Management systems Role & functions of management. Productivity, basic concepts, classification, measurement and improvement. Role of work study, work measurement and work sampling.

Facilities planning and design

Plant location, material handling systems, types of production, MRP-II, group technology, make or buy decisions, demand forecasting, material requirement planning, inventory models and just in time (JIT) technique, production planning, scheduling problems & models, project management, techniques for PERT & CPM, network scheduling, activity crashing and resource leveling.

Human resource management

Recruitment process, job evaluation, performance appraisal, non-financial and financial incentives, training, labour relations, management theories.

- 1. Production & Operations Management *By Evert E. Adam Jr and Ronald*. Prentice Hall
- 2. Production Management By Kieth & Loekyer.
- 3. Operations Management By Jay Heizer & Barry Render, Prentice Hall

MS-402 PROJECT MANAGEMENT (3,0)

Specific Objectives:

- To understand modern project management techniques related government regulations.
- To implement modern project management techniques using software.

Course Outline:

Fundamental principles, project proposals and feasibilities, project life cycle; project organization and human resource management; PM planning; Work breakdown structure; Estimating time and cost; Precedence relationships; Project scheduling and control techniques; Project risk analysis; Time compression and resource leveling; Computerized project management; special software packages

Recommended Books:

- 1. Project Management: A Systems Approach to Planning, Scheduling, and Controlling by Harold Kerzner, John Wiley
- 2. Case studies in project management, 2nd Edition, by Harold Kerzner, John Wiley
- 3. Project Management Body of Knowledge (PMBOK) 4th Edition, by P. M.I.

MS-403 OPERATIONS RESEARCH (3,0)

Specific Objectives:

- To understand the Operations Research tools and techniques.
- To understand working and application of computer software packages.

Course Outline:

Operation Research Techniques and basics, Linear programming, graphical method, simplex method dynamic programming, sensitivity and post-optimal analysis, transportation models, Queuing theory (weighting live models). Replacement Models. Simulation. Basic principles, discrete models vs. continuous system simulation, Markov Chain.

- 1. Operations Research by H. A. Taha, Prentice Hall
- 2. Operation Management-Strategy and analysis by Krajewsky and Ritzman 3. Operations Research by S. Kalavathy, Vikas Publishing House.
- 4. Operations Research: Applications and Algorithms by Wayne L. Winston

MS-404 TOTAL QUALITY MANAGEMENT (3,0)

Specific Objectives:

- To understand the philosophy of total quality management
- To implement the tools and techniques in the organizations.

Course Outline:

Fundamental principles; Standards; Techniques for quality analysis and improvements; statistical methods and SPC. Acceptance sampling; QFD; Value engineering; Cross-functional management and benchmarking; ISO-9000 application, clauses, and implementation issues, Six Sigma.

Recommended Books:

- 1. Total Quality Management with text cases by John S. Oakland, Butterworth-Heinemann
- 2. Total Quality Management by Besterfields, Prentice Hall.
- 3. Statistical Quality Control by D.C. Montgomery.

MS-405 OPERATIONS MANAGEMENT (3,0)

Specific Objectives:

- To understand the philosophy of Operations management
- To implement the tools and techniques in the organizations.

Course Outline:

Basics of managing manufacturing and service organizations; strategic decision making; facility location and layout; job design and work compensation; demand forecasting; capacity and material planning; scheduling in various environments; emerging trends in managing operations. Use of quantitative management tools after introducing fundamental concepts.

Recommended Books:

- 1. Operations Management by Nigel Slack, Stuart Chambers and Robert Johnston.
- 2. Operation Management by Jay Heizer and Barry Render.

MS-406 BUSINESS AND ENTREPRENEURSHIP (3,0)

Specific Objectives:

• To understand the philosophy of Business and Entrepreneurship

• To implement the tools and techniques in the organizations.

Course Outline:

Evolution of the concept of entrepreneur, Characteristics of an entrepreneur, Distinction between an entrepreneur and a Manager, in Economic Development, Factors affecting entrepreneurial growth (economic, Non-Economic and Government factors)

Critical factors for stalling a new enterprise. Ingredients for a successful new business. Self-assessment and feedback, Personal entrepreneurial competencies. Goal setting.

Creativity and sources of new business ideas, the difference the difference between ideas and opportunity and creativity. Assessing business opportunities in Pakistan. Screening and evaluating opportunities Product planning and development process. Creating parallel competition by developing a similar product or service, Product life cycle, Finding sponsorship. Acquiring a going concern, E-Commerce and business start-up and growth.

Marketing as a philosophy, marketing management: Creating a marketing plan, Analyzing the environmental situation and the market opportunity, Setting marketing objective, Formulating a marketing strategy.

The business plan as selling document, reasons for writing a business plan your company: What's your identity, Field work started, Marketing issues: Who are your buyers?., Product issues: What are you selling?, Production exercise, Sales and Promotion: Financial issues: Targeting and writing the plan: Business Plan compilation exercise.

Franchising, becoming a franchisees versus starting a stand-alone business, the franchisee contract, Non-contractual considerations of buying a franchise, Limitations of franchising.

Recommended Books:

- Rober D. Hisrich and Michael P. Peter, Entrepreneurs/lip,5th Edition, McGraw-Hill
- 2. S. S. Khanka, Entrepreneurial Development
- 3. Irving Burstiner, the small Businesses Handbook
- 4. Bruce A. Kirchhoff, Entrepreneurship and Dynamic Capitalism
- 5. Modern Business Management, A System & Environment Approach by McGraw-Hill
- 6. William D. Bygrave, The Portable MBA in Entrepreneurs/lip Entrepreneurship CEFE, Germany, Development Manual

ME-407 SAFETY, HEALTH AND ENVIRONMENT MANAGEMENT (3,0)

Specific Objectives:

- To understand the philosophy of Safety Health and Environment
- To implement the concepts in the organizations.

Course Outline:

Introduction of Health and Safety, Industrial Safety: introduction objectives of Safety, Importance of Safety in an industry, Industrial accidents, Effects of accidents, Types of accidents incidence of fire. Fire prevention and control.

Principles of accident prevention, hazard analysis. Legal, humanitarian and economic reason for action. Safety inspection procedures. Safety training, First aid and emergency procedures,.

Introduction: importance of clean environment, Scale of Environmental Pollution. Environmental Act. Health and Safety Act.

Atmospheric Pollution: Types of Atmospheric pollution, Their Causes and Effects on Human Health, Available Technologies for Controlling Pollution. Industrial Waste: Solid Waste, Industrial Effluents and Waste Gases, waste treatment plants.

Noise Pollution: Measurement of Noise level, Effect of excessive noise on human health. Remedial Measures.

ISO Standards for Safety and Health and Environment

Recommended Books:

1. Safety at Works 4th Edition By John Ridley, Butter Worths Publishers **MS-408 PRODUCTION MANAGEMENT (3,0)**

Course Outline:

Essentials of production management. Productivity Analysis, Forecasting Techniques, Regression and correlation analysis, Inventory models techniques and project management analysis. Computer solutions with excel spreadsheets.

Recommended Books:

1. Factory & Production Management By K. G. Lockyer, Pitman Publishing