

# **FINAL YEAR**

## **FALL SEMESTER**

### **AU-415 VEHICLE DESIGN**

#### **Introduction to Vehicle Design:**

Vehicle Design process; Total design concepts, Vehicle design parameters and specifications; Automotive Materials.

#### **Automotive Structure:**

Automotive structures, basic assumptions regarding structural element interaction and stress distributions, standard loading cases, assessment of maximum applied forces under various dynamic conditions (crashworthiness), Bending and Torsional stiffness, modeling using structural surfaces, load path, response to impact, global bending of automotive bodies, Modal analysis of structures, conventional, monocoque and space frame structures, Conventional and modern techniques in Chassis design and development,

#### **Vehicle Design Assessment Techniques**

NCAP (New Car Assessment Program) , FMEA (Failure Mode and Effect Analysis), Noise Vibration Harshness (NVH), DFA (Design for Assembly) and DFM (Design for manufacturing). Automotive Body and Chassis design standards.

### **AU-416 MECHATRONICS**

#### **Introduction**

What is mechatronics; scope of mechatronics; architecture of mechatronics; mechatronics and other fields. Mechanical motion converters, kinematic chains, cams, gear trains, belt and chain drives, bearings.

#### **Mechanical (Pneumatic and Hydraulic) Actuators**

Rotary actuators (pneumatic and hydraulic motors); pressure control valves, cylinders, and process control valves.

#### **Electrical Actuation System**

Manual switches, solid-state switches, solenoids, AC motors, DC motors, stepper motors.

#### **Basic System Models**

Mathematical models, building blocks of (mechanical system, electrical system, fluid system, thermal system).

#### **System and Control**

System representation and its transfer function; dynamic response of first –order and second -order systems; closed loop controllers (PID controller, digital controller).

#### **Micro Controller and Programming**

Internal architecture; addressing modes; programming instructions (arithmetic, data transfer, logical, Boolean and branching); timer/counter programming.

#### **Programmable Logic Controller (PLCs)**

Introduction; advantages and disadvantages of PLCs; system description (power supply, CPU, I/O modules); basic programming (arithmetic, number comparison) and timer and counter functions.

#### **Mechanical Systems and Design Methods**

Mechatronic approach; engineering systems; control architecture; design processes and steps; types of design.

#### **Time Scale Effects**

Linear control system, determination of system performance and design with reference to stability, transient response, steady state accuracy and frequency response; Laplace transformation method; root locus; Nyquist criteria and bode plots; conformal plotting; series parallel and feedback techniques of system compensation three term pneumatic controllers; servomechanism; electrical, hydraulic and pneumatic amplifier.

#### **Instrumentation**

Analysis of the performance of electro mechanical transducers used in control.

## **ME-315 HEAT AND MASS TRANSFER**

### **Conduction:**

Steady state conduction; general equation for three dimensional geometries; one dimensional analysis; Multi layer wall; Overall heat transfer coefficient.

Unsteady state heat transfer for simple geometries; lump capacity method; internal resistance in solid.

Transfer with internal heat sources; Extended surface heat transfer-fins.

### **Thermal radiation:**

Basic concepts; surface characteristics blackbody; grey body, emission in defined wave band; radiation intensity; energy exchange in black and grey bodies.

### **Convection Heat Transfer:**

Basic concepts; momentum and thermal boundary layer fundamentals, dimensional analysis; theoretical analysis for flat plates; laminar and turbulent flow.

### **Forced Convection:**

Laminar and turbulent flow over flat plates and inside tubes and ducts, Empirical correlations.

### **Free Convection:**

Similarity parameter, boundary layer, convective coefficients in plates; empirical correlations.

Heat transfer with change in phase; boiling; condensation.

### **Heat Exchangers:**

Types; preliminary design.

### **Mass Transfer:**

Mass transfer operations; Diffusional mass transfer; mass transfer coefficients; empirical correlations: analogy of heat, mass and momentum transfer; simultaneous heat and mass transfer.

## **AU-442 FEM and FVM: Applications in Automotive Engineering**

### **Computational Modelling – Basic Concept:**

Introduction, Physical problems in Engineering; Computational Modelling Using FEM; Simulation visualization.

### **Review of Mechanics of Solids and Structures:**

Equations for beams; Truss members; Two-dimensional solids; Three-dimensional solids.

### **Fundamentals of Finite Element Method:**

Introduction; Strong and weak forms; Hamilton's principle; FEM procedure; Static analysis; FEM for trusses, beams, two-dimensional solids, and three-dimensional solids.

### **Numerical Integration Techniques:**

Techniques for solving linear (matrix) equations; direct method, iterative methods; Techniques for solving non-linear problems.

### **Finite Element Modelling Technique:**

Introduction; CPU time estimation; Geometry modeling; Meshing, mesh compatibility; Use of symmetry; Modeling offsets, supports, joints; Contact formulations.

### **Special Topics in FEM:**

Crash Analysis; Noise-vibration-harshness (NVH) analysis.

### **Introduction to Computational Fluid Dynamics (CFD):**

Governing equations; Discretisation with help of Finite Volume Method; simple one dimensional flow problem

## **ELECTIVE COURSE:**

## **AU-423 BODY ENGINEERING AND AUTOMOTIVE STRUCTURES**

### **Structures:**

Types of automotive structures; body concept for design in automotive structures; design criteria; basic assumptions regarding structural element interactions and stress distributions; standard loading cases; assessment of maximum applied forces under various dynamic conditions: torsion, vibration; modelling using structural surfaces; load paths; response to impact; first order modeling of thin-walled structures, energy absorption by plastic collapse; global bending of automotive bodies; crashworthiness; limit design and springback.

### **Topology:**

Material selection; packaging and manufacturing constraints.

### **Chassis:**

Analysis of trusses by method of joints, analysis of frames; monocoque structures and elements of structures; spot welding and corrosion protection; load points and FEM analysis of a vehicle chassis.

Definition of surface engineering, diffusion techniques, deposition methods, high and low energy beam; boronising and other surface treatments.

### **Fracture strength and crack propagation:**

Their effect on safe life and flaw tolerant design

## **AU-433 AUTOMOTIVE HEALTH SAFETY & ENVIRONMENT**

### **Introduction**

Accidents (Nature, Effects, Causes and Cost), Importance of Health and Safety for Engineers, Safety (General Responsibility, Principles, Policy, Inspection, Planning), Safety Measures in Automotive Industry, Safety and Health Economics, Environment and need for Environmental Control, Environmental Factors in Automotive Industry and their effects.

### **Vehicle Safety**

Concepts and Principles of Vehicle Safety, Adaptive Cruise Control (ACC), Traction Control System (TCS), Electronic Stability Program (ESP), Braking Systems and Antilock Braking systems (ABS), Electrical Safety, Protection and safety of fuel tank, Fire Protection, Vehicle Safety Technologies (Aerodynamics, Four Wheel steering, Adaptive headlights), Vehicle Fitness and Inspection.

### **Occupant Safety**

Restraint Systems (Seat Belts, Airbags), Head Restraints, Child Restraint System, Multipoint Restraint Systems, Passive Restraints, Occupant Sensing Methodologies, Bullet Proofing, Personal Protective Equipment, First Aid, Emergency Evacuation, Safe Driving Practices.

### **Safety and Environmental Standards**

ISO Standards (ISO 14000), Total Safety Management (TSM), OSHA Standard, Emission Standards and Regulations (EURO compliance), Environmental Protection Agency (EPA) standards, Overview of Pakistan Motor Vehicle Act, Highway Safety Standards.

### **Automotive Convenience Systems**

Driving Assistance System (Safety and convenience), Vehicle Security Systems, Navigation Systems, Traffic Telematics, Parking systems.

## **AU-444 HYBRID VEHICLE & DRIVES**

### **Introduction and architecture of Hybrid Vehicle**

Types of Hybrid Vehicles, Economic and Environmental Impact of Hybrid Vehicle, Basic Architecture of Hybrid Drive Trains and Analysis of Series and Parallel Drive Train, Power Flow in Hybrid Electric Vehicles (HEVs), Torque Coupling and Analysis of Series and Parallel Drive Train.

### **Electric Motors and Generators for Hybrid Electric Vehicles (HEVs)**

Induction Motors and their Configuration and Optimization for HEVs/EVs, Induction Motor Drives, Control and Applications in EVs/HEVs, Permanent Magnet Motors their Configuration and Optimization, Permanent Magnet Motor Drives, Control and Applications in EVs/HEVs, Role of Switch Reluctance Motors and present issues, Concept of Regenerative Braking.

### **Converters for Hybrid Vehicles**

Buck (Step-down) converter, Boost (Step-up) Converter, Buck-Boost Converter, DC-AC Inverter for EV and HEV Applications, Voltage source Inverter (VSI), Current Source Inverter (CSI).

### **Energy Storage**

Architecture of the electrical energy management system: Battery System, Fly Wheel, Super Capacitors, Energy Storage System, Types of Batteries, Battery Run Time, Test case, Terminal Voltage Capacity, Charging and Discharging rate calculations, Battery Fuel Mode Selection, Fuel Cell System for Hybrid Vehicle.

### **Control System for HEVs**

Energy Management Strategies (EMS) and its General Architecture, Rule and Optimization based EMS, EMS based on Deterministic Rules. EMS based on Fuzzy Rule.

### **Hybrid Vehicle Modelling**

Modelling Vehicle Acceleration: Acceleration performance parameters, Modelling the acceleration of Hybrid Electric Vehicle, Modeling Electric Vehicle Range, Driving cycles, Range modelling of battery electric vehicles, Constant velocity range modelling, Range modelling of fuel cell and hybrid electric vehicles.

## **AU-417 AUTOMOTIVE PAINTS AND COATINGS**

### **Introduction**

Paints and coatings, Classification of Paints and coatings, Scope of Automotive Paint Industry, Current Paint Manufacturers.

### **Automotive Painting Processes**

General Painting Process, Pretreatment, Sand and Shot blasting Sequence of Treatment, Degreasing, Activation, Zinc Phosphating, Baking Oven, Passivation, Pre-Treatment of multi-metal car bodies, Pre-Treatment of Plastic Parts, Car Body Pre Treatment Lines, Primer Surface, Sealing and Underbody Protection, Top Coats and Clear Coats.

### **Electro Deposition (ED) Coatings**

Types of ED coatings. Difference between Anodic and Cathodic ED Paint Process. Layout of an ED Paint Shop. Design of Car ED Lines. General Functions and Equipment of an Electro-coat Line.

### **Paint Shop Design and Quality Aspects.**

Typical Layout of an Automotive Paint Shop, The designing of an Automotive Paint Shop, Design capacity of Paint Shop, Quality Aspects, measurement of Paint thickness, measurements of basic paint properties (Viscosity, scratch resistance, stone chip resistance), Leak and shower test.

### **Paint Defects during Applications and their Prevention.**

Paint Defects, Why defect appears and How to repair the defects, Prevention of paint defects.

## **SPRING SEMESTER**

### **AU-431 VEHICLE THERMAL MANAGEMENT**

#### **Vapour Compression Cycle:**

Coefficient of performance; multi-effect and multi stage compression cycles; introduction to different types of refrigeration machines and heat pumps; refrigerants and brines, their properties; distribution of refrigerant.

#### **Vehicle Heating:**

Heat pump arrangement, electric heating.

#### **Air Conditioning:**

Cooling and heating load calculations using ASHRAE manual and available software with emphasis on vehicles e.g. cars, passenger vehicles, specialised vehicles for food items etc.

A study of controlled passenger compartment environment

Use of psychometric charts; Air conditioning, (de)humidification and heating requirements for comfort in a vehicle; Air distribution system in a vehicle; automatic temperature and humidity control; designing of a complete HVAC system; prevention of noise in the cabin.

Insulating vehicle to conserve energy and increase mileage.

#### **Use of Waste Heat:**

Description and design of engine cooling system; available waste heat in cooling water and exhaust gases; use of waste heat of engine.

### **AU-422 AUTOMOTIVE TRANSMISSION & DRIVES**

#### **Over view:**

Overview of vehicle transmission/drive train components and layouts.

#### **Clutch:**

Design calculations; engagement time; performance during engagement and thermal properties; synchromesh design and gear engagement calculations.

#### **Manual Transmissions:**

Theory and power flow of standard transmissions/transaxles; gearbox; synchronizers; synchromesh design and gear engagement calculations; lubrication of gears.

#### **Automatic and Semi Automatic Transmissions:**

Hydrokinetic transmissions: fluid coupling and torque converter; epicyclic gears; compounding; performance characteristics; matching; overview of continuously variable transmission (CVT) designs.

Comparison of performance attributes for the different types of transmissions.

#### **Power Train Mismatching:**

Combined engine, transmission and vehicle characteristics, gear ratio selection criteria and calculations, effect of undergearing/overgearing on vehicle performance and fuel economy, impact of engine type and characteristics.

Universal and C-V joints; drive shafts; axles and differentials.

Fundamentals of power transmission for belts and chains; linkages; cams; functions and principles of operation and applications of governors and gyroscopes.

#### **Different Systems:**

Hydraulic, electro-hydraulic and pneumatic systems: automotive steering, brakes, windows operation and other special applications.

### **AU-441 PRODUCT DEVELOPMENT AND OPERATIONS MANAGEMENT**

#### **Product Development:**

**Product development strategies:** understanding customer needs; translating customer needs into new product concepts with realistic technical specifications and aesthetics; different approaches of comprehending the

marketing of new products. Product development cycle time and its optimization. Implementing concurrent engineering practices; measuring the success of new product development effort.

**Cost Estimation:** Material cost; Direct and indirect labour cost and over head cost. Cost structure; Factory cost, Design & manufacturing cost, Process cost. Selling price; Estimation of cost elements. Quotation development.

**Operations Management:**

Introduction to operations management; Decision making, Site selection; Production planning methods; Master scheduling; MRP; Product structure; Types of MRP; Production control system; Purchasing and procurement. Project planning & network analysis; CPM/PERT; Network development; Establishment of critical path; Probabilistic statements. MS project

**Inventory Control:**

Types of inventory, Inventory cost, Independent versus dependant demand, Inventory management, Inventory models, EOQ/EPQ models, Types of control systems, Selective inventory control.

**Forecasting:**

Supply chain strategies, Capacity planning, Managing demand Break-Even analysis, Forecasting approaches, Time series forecasting, Casual forecasting methods, regression and correlation analysis.

**Scheduling & Analysis of Assembly Lines:**

Aggregate planning strategies, Methods of aggregate scheduling, Short term scheduling; Loading jobs in work centers, Sequencing of jobs, Rule-based dispatching systems; Job shop scheduling; Production control charts, scheduling techniques; Analysis of transfer lines without storage, Partial automation. The assembly process, Manual assembly lines, The line balancing problems; Line Balancing Techniques.

**Project Planning & Network Analysis:**

CPM/PERT; Network development; Establishment of critical path; Probabilistic statements. MS Project

**Method Study & Work Measurement:**

Definition, objectives, Method study charts and diagrams, motion classification. Techniques of work measurements, stop watch time study, performance rating, standard timing, allowance factors, Work sampling; Determination of sample size, making random observations.

## **AU-499 AUTOMOTIVE ENGINEERING PROJECT**

Selected problems from the fields related to automotive engineering requiring design, manufacturing, development of problem specific software, preparation of drawings, fabrication of prototype/models and laboratory experimentation shall be assigned to individual students or groups of students. Grading shall be based on the reports produced by individual students and their critical evaluation through an oral examination.

## **MG-481 ENTREPRENEURSHIP**

- **Understanding the Entrepreneurship Mind-set**
  - The revolution impact of Entrepreneurship
  - The individual Entrepreneurship Mind-set
  - Corporate Entrepreneurship Mind-set
  - The Social and Ethical perspectives of Entrepreneurship
- **Launching Entrepreneurship Ventures**
  - Creativity and innovations
  - Methods to initiate ventures
  - Legal challenges in Entrepreneurship
  - The search for Entrepreneurship Capital
- **Formulation of Entrepreneurship Plan**
  - The assessment of function with opportunities
  - The marketing aspects of new ventures
  - Financial statements in new ventures
  - Business plan preparation for new ventures
- **Strategic Perspectives in Entrepreneurship**
  - Strategies growth in Entrepreneurship
  - Valuation challenges in Entrepreneurship
  - Final harvest of a new venture