M. TECH – AUTOMOTIVE ENGINEERING

Department of Mechanical Engineering

This program is designed to enable the graduate engineers with appropriate background to specialize their careers towards Automotive Engineering and Automotive System Design. The objective of the program is to strengthen the ability of the student to solve complex technological problems and to develop skills that will prepare the student to work effectively in close collaboration within a multidisciplinary team and facilitates to develop R&D competency.

Besides mandatory core courses, a number of electives are offered to the students to suit their acumen in the emerging areas and are designed by professionals from the Industry. The students are periodically assessed by experts and they are also motivated to take up internships in the Industry. Since India is being recognized as a hub for the global players, this course is committed to produce automotive engineers with creative capabilities and caliber to solve challenging problems and is intune with the objectives envisioned by the University.
# CURRICULUM

## First Semester

<table>
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<tr>
<th>Course Code</th>
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### Credits

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* Non-credit course

## Second Semester

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**Credits 12**

**Total Credits 65**

### List of Courses

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#### Subject Core

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**Students undertaking and registering for a Live-in-lab project can be exempted from registering for an elective course in higher semester.**

18MA601  
**APPLIED MATHEMATICS**  
3- 0- 0- 3


**Differential Equations:**  

**TEXT BOOKS/REFERENCES:**

18AT601  
**AUTOMOTIVE CHASSIS AND TRANSMISSION SYSTEMS**  
3- 0- 0- 3


TEXT BOOKS/REFERENCES:


18AT602 INTERNAL COMBUSTION ENGINES 3-0-0-3


Combustion in Spark-Ignition Engines and Compression-Ignition Engines, Lubrication, Crevice flow, blowby, Prechamber flow, Cooling, Nature of engine heat transfer and its basic considerations, Parametric relationship of engine output with heat transfer, Convective and radiative heat transfer in engines; Heat transfer correlations in engines, Boundary layer model for in cylinder heat convection; Thermal loading and transient heat transfer through walls.

Advanced combustion technology- HCCI, PCCI, RCCI Engines, Lean burn engines-Cycles- Miller cycle, Atkinson cycle
Simulation using appropriate tools (GT Power / Autonomie)

TEXT BOOKS/REFERENCES:


18AT603 AUTOMOTIVE MATERIALS AND MANUFACTURING 3-0-0-3

Introduction to common engineering materials; metallic and non-metallic automotive materials. Materials and processes with relevance to automotive applications. Advanced materials, light weight material, nano material, synthesis and in-situ materials for automotive applications, corrosion, Standards for automotive materials.

High strength low alloy steels (HSLA), Advanced high strength steels, dual phase steels, martensitic steels etc., Advanced plastics and composites, Novel material for automotive applications, ultra-light weight material, Graphene, Battery materials and technology, case studies related to automotive applications. Case studies on crank shaft, connecting rod, piston, gear and gear box, propeller shaft.


Futuristic technology and material for automotive applications, Designing hybrid materials- material for auto piloting, manufacturing considerations for various lightweight automotive structures, 3D printing-materials, processes and applications. Case studies on Li-ion battery, polymer composites and sensor materials.

TEXT BOOKS/REFERENCES:

Introduction to Electronic systems in Automotives – Sensors and Actuators for body electronics, power train and chassis systems. Body electronics domain- Automotive alarms, Lighting, Central locking and electric windows, Climatic Control, Driver information, Parking, etc.

Power train and chassis control domain – Engine management, Transmission control, ABS, ESP, Traction Control, Active Suspension, passive safety, Adaptive Cruise Control, etc. Hardware implementation example of simple automotive systems using Sensors, Controller, Actuators etc.


TEXT BOOKS/REFERENCES:


18AT621 INTERNAL COMBUSTION ENGINES LAB 0-0-1-1

Disassembly and assembly of IC Engines)- Valve timing and port timing diagram- Heat balance test -Performance and emission study on SI/CI Engine using 13 mode and 8 mode test cycle, with alternative fuels, 5 mode test cycle for constant speed engines- Performance, combustion and Emission study on the effect of different fuel injection pressure and timing on the engine- Performance, combustion and emission characteristics study on the effect of preheated air and fuel.-Experiments on single and multi-cylinder SI/CI Engines to find friction power-Combustion analysis of IC engines using P-O data.

18AT622 AUTOMOTIVE ELECTRONICS LAB 0-0-1-1


MK40DX256 - IO Configuration, Timer, PWM- DC motor speed control, ADC, DAC, Periodic Timer Interrupt, sensor interfacing to MK40DX256 via CAN, OBD exercises using BOSCH KTS 540 kit.


Aerodynamic forces on ground vehicles - Wheel load - traction due to Aerodynamic forces - safety, performance characteristics –Problems-Three dimensional effects - Design features to reduce drag. This module will introduce the student to computational analysis and kinematic and force analysis of systems with appropriate software.

Appropriate ADAMS models to be developed for Multibody Dynamics study.

TEXT BOOKS/REFERENCES:


18AT613 ALTERNATE FUELS, EMISSIONS AND CONTROL  3- 0- 0- 3


TEXT BOOKS/REFERENCES:


18AT614

NVH AND REFINEMENT  3-0-0-3


TEXT BOOKS/REFERENCES:

Fundamental Concepts in Mathematical Modelling


Modeling of First–order and Second–order Systems


Systems Engineering and Application


TEXT BOOKS/REFERENCES:


**HYBRID ELECTRIC VEHICLES**

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance. Electric Drive-trains and Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.
Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.


Sizing the drive system: Matching the electric machine and the internal combustion engine, Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

TEXT BOOKS/REFERENCES:


18AT623 NVH LAB 0-0-1-1


18AT624 VEHICLE DYNAMICS AND SIMULATION LAB 0-0-1-1

Homologation trials - Acceleration test, Brake test, Single lane change test, Double lane change test.
Steering effort test.- Steering torque measurement- Brake force measurement test- Gear shift effort test.
Pitch, Yaw and roll measurement- Steering robot demonstration.
Simulated Vehicle performance on road profile-creating and customizing the vehicle model to the requirement-Exercises using simulation tools

18RM600  RESEARCH METHODOLOGY  2-0-0-2

Unit I:

Unit II:
Problem Formulation, Understanding Modeling & Simulation, Conducting Literature Review, Referencing, Information Sources, Information Retrieval, Role of libraries in Information Retrieval, Tools for identifying literatures, Indexing and abstracting services, Citation indexes

Unit III:
Experimental Research: Cause effect relationship, Development of Hypothesis, Measurement Systems Analysis, Error Propagation, Validity of experiments, Statistical Design of Experiments, Field Experiments, Data/Variable Types & Classification, Data collection, Numerical and Graphical Data Analysis: Sampling, Observation, Surveys, Inferential Statistics, and Interpretation of Results

Unit IV:
Preparation of Dissertation and Research Papers, Tables and illustrations, Guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript. References, Citation and listing system of documents

Unit V:

TEXT BOOKS/ REFERENCES:
18AT701  COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER  2-0-2-3

Mathematical description of fluid flow and heat transfer-Conservation equations for mass, momentum, energy and chemical species-Classification of partial differential equations

Discretization techniques using finite difference and finite volume formulations, Direct & Iterative Techniques or solving Discretized Equations - TDMA,


TEXT BOOKS/REFERENCES:


18AT702  FINITE ELEMENT METHODS AND COMPUTATIONAL TOOLS  2-0-2-3


TEXT BOOKS/REFERENCES:


Vehicle tests – Tests on components and systems – Instrumentation and Transducers – EMI/EMC testing and regulations - Safety and crash testing and Regulations - Materials and material testing - Servo-hydraulics and fatigue testing - CMVR – Indian and Automotive Industry standards – International standards and WP 29

Virtual product development and computer aided engineering – virtual testing - Road to lab to desktop - Design of experiments – Basic concepts - application of statistics – Analysis of variance - factorial testing – Fractional factorial testing - Taguchi methods.

TEXT BOOKS/REFERENCES:


18AT704 SPECIAL TOPICS IN ADVANCED ENGINEERING APPLICATION 3-0-0-3

- Light weighting for electric vehicles
- Green engine technology.
- Battery management systems.
- Hybrid Technology
- Tribology of Automotive Components
- Additive Manufacturing for Automotive Applications.
- Electrocoating for automotive applications.
- Connected cars-Requirements & Technical feasibility.
- Advancement in onboard diagnostics.
- Autotronics and Vehicle Intelligence.
- Visco-Elastic Materials and Vibration Control
- Flow-Induced Noise and Vibration Sources in Automotive systems.
- Surface Coatings for Automotive Applications.

**Note:** Evaluation for this course is based on Review documents, Reports, and Presentation

18AT705  
**OFF-HIGHWAY MOBILITY**  
3-0-0-3

Study of morphology, operational characteristics, and design considerations of off-road vehicles used in agriculture, infrastructure and construction. Traction and Tractor Performance. Tractor, harvester, windrowers: engine performance and design, vehicle testing, turbo chargers and intercoolers, drive trains, chassis mechanics, hydraulic systems including PTO. Tractor Test procedure – Nebraska Test. Emission norms and legislative requirement for off highway vehicles.


**TEXT BOOKS/REFERENCES:**

5. Gianpiero Mastinu, Manfred Ploechl “*Road and Off-Road Vehicle System Dynamics Handbook*” CRC Press, 2014

18AT706  
**VEHICLE BODY ENGINEERING**  
3-0-0-3

CAR BODY DETAILS: Types: compact, hatch-back, saloon, convertibles, limousine, estate car, racing and sports car. Car body construction; design criteria, prototype making, Body In white, creating the inner panels, underfloor panels, detailing of class A surfaces (Flanges, seatings, hemming) from manufacturing point of view.

BUS BODY DETAILS: Types: mini bus, single decker, double-decker, two level and articulated bus. Bus body layout; floor height, engine location, entrance and exit location, seating dimensions.
Constructional details: frame construction, double skin construction, types of metal sections used, Conventional and integral type construction, Bus Body Code and Regulations

COMMERCIAL VEHICLE DETAILS: Types of body; flat platform, drop side, fixed side, tipper body, tanker body, Light commercial vehicle body types. Dimensions of driver's seat relation to controls. Driver's cab design.


Mechanism analysis using software – max. of 3 hours of class,

TEXT BOOKS/REFERENCES:

18AT707 AUTOMOTIVE SAFETY AND LIGHTING 3-0-0-3

Statistics of accidents - Accident investigation and analysis-. Automotive Safety - Active and passive safety, Driver assistance systems in automobiles, Definitions and terminology-Balance of stiffness and toughness characteristics and energy absorption characteristics of vehicle structures, Design of crash crumple zones, Optimization of vehicle structures for crashworthiness, Types of impacts, and Impact with rebound, movable barrier tests, Roll over crash tests, Side and Frontal Pole Impact-Behavior of specific body structures in crash testing, Regulatory requirements for crash testing-National and international Regulations, test requirements and testing procedure


TEXT BOOKS/REFERENCES:

18AT708 AUTOMOTIVE INFOTRONICS

Introduction to Automotive Controllers – S12XE: 18-Bit Automotive Microcontroller, Port Integration, Memory mapping control, memory protection, External bus interface, interrupts, clock and reset, ADC, Scalable Controller Area Network, periodic interrupt timer, PWM, serial peripheral interfaces, Timer module

Body Controller Application Example, Programming using code warrior IDE. Introduction to longitudinal and lateral vehicle control, Modeling and simulation study of ABS, Adaptive cruise control, Electronic stability control, Active suspension control


TEXT BOOKS/REFERENCES:

18AT709 NEW PRODUCT DEVELOPMENT

Concept & Ideation: Styling concept creation, realistic rendering with car paints/textures. Translating the cloud of points of clay model into surfaces with reverse engineering. Class A surface creation – refining the styling surfaces to make them Class A surfaces with manufacturability.

New product development – different steps in NPD, VOC/QFD, Product and brand strategy. Packaging, market research and its influence .New products as projects.Design theory and
methodology - innovation methodologies - Eco-design - User centered design Organisational structures and cross functional teams. Marketing and R & D interfaces.

Concept - context and role of managing uncertainty – Role of individual in innovation process. Innovation and operation management – Managing intellectual property – Managing technology and knowledge. Strategic alliances and network, R&D projects, Technology transfer in innovation.

TEXT BOOKS/REFERENCES:


18AT710 AUTOMOTIVE HVAC, CABIN COMFORT AND ERGONOMICS 3- 0- 0- 3


Applications of HVAC fundamentals to analysis and design of automotive air conditioning systems. Psychometrics, passenger thermal comfort, refrigeration cycles and system design, central and Unitary systems, heating system design, air flow circuits, Air cleaning, ventilation, air space diffusion, compact heat exchanger design, controls and instrumentation. Cabin comfort- In-car air conditioning - overall energy efficiency - air management.

Vehicle Ergonomics : Introduction to human body - Anthropometrics and its application to vehicle ergonomics and cockpit design- Driver comfort – seating, visibility, man-machine system- consideration of women drivers-Psychological factors – stress, attention- Passenger comfort - Ingress and egress, spaciousness, ventilation, temperature control, dust and fume prevention and vibration - Interior features and conveniences .

TEXT BOOKS/REFERENCES:

4. ASHRAE Handbooks.
5. B.Peacock, WaldeimarKarwowski; “Automobile ergonomics.” Publisher: CRC; 1 edition, 1993

18AT711 MEMS (MICRO-ELECTRO-MECHANICAL SYSTEMS), 3- 0- 0- 3

SENSORS AND TECHNOLOGIES FOR AUTOMOTIVE APPLICATIONS
(Prerequisite 18AT708)

Micro electro mechanical systems (MEMS), devices, and technologies. Micro-machining and microfabrication techniques, including planar thin-film processing, silicon etching, wafer bonding, photolithography, deposition, and etching.

Transduction mechanisms and modeling in different energy domains. Analysis of micromachined capacitive, piezoresistive, and thermal sensors/actuators and applications.

Computer-aided design for MEMS layout, fabrication, and analysis. MEMS for automotive applications. Different type of sensors and actuators. Control systems for various applications.

TEXT BOOKS/REFERENCES:


18AT712  TRIBOLOGY  3- 0- 0- 3

Tribological considerations in design of gears, cams, reciprocating components, Engine tribology, transmission drive line-transmission, traction drive, universal and constant velocity joints, wheel bearings, drive chains, lubrication regimes in the engine. Friction and Wear - surface properties, surface parameters and measurements, sliding friction, rolling friction, modified adhesive theory, engine friction, losses and engine design parameters - mechanism of wear, wear testing and methods of wear measurements.

Bearing, Lubrication and Automotive Lubricants - hydrodynamics, generalized Reynold’s equation & physical significance of terms, pressure distribution and load carrying capacity equations for hydrodynamic journal bearing - thrust bearings, Raleigh bearing sintered bearings.

Automotive Lubricants and additives - Type of lubricants, properties and testing, service, classification of lubricants, lubrication of tribological components standard tests, engine oil performance designations, transmission fluids, gear, axle, solid, EP lubricants, ferrography and other rapid testing methods of lubricant contamination Hydrostatic bearings, bearing pad coefficients, squeeze film lubrication Elastohydrodynamic Lubrication, rolling of two cylinders, fatigue and diagnosis.

Road tyre contacts, hydroplaning. Preventive Maintenance - schedule, Noise, wear, corrosive maintenance. Signature analysis of Bearings and Gears, real time condition monitoring using vibration analysis - Periodic Maintenance - Maintenance of batteries, Maintenance of auxiliaries Lubrication system, lubrication charts, Cooling system Maintenance, Maintenance of Electrical
system, testing of starters, alternators, ignition coils, wiring harness, horns, wipers, maintenance of drive line system.

TEXT BOOKS/REFERENCES: