I SEMESTER

18AE01 COMPUTATIONAL MATHEMATICS

NUMERICAL SOLUTION OF SYSTEM OF EQUATIONS: Solving system of linear equations – Gauss Jacobi and Gauss Siedel methods, successive over relaxation method, system of non-linear equations – Newton’s method. Interpolation: cubic spline interpolation, Bézier curves and B-spline curves, least squares approximations. (8+7)


NUMERICAL SOLUTION TO PDE: Finite difference method: Liebmann’s method for Laplace equation and Poisson equation, explicit method and Crank-Nicolson method for parabolic equations, explicit method for hyperbolic equations. (8+7)

MODELLING AND SIMULATION: Simulating deterministic behaviour, area under a curve, generating random numbers, simulating probabilistic behaviour, inventory model: gasoline and consumer demand. (8+7)

REFERENCES:

Total L: 32 + T: 28= 60

18AE02 AUTOMOTIVE SYSTEMS

FRAME AND BODY: Introduction, Vehicle classification, frame types-conventional, integral construction – ladder chassis, sub frames, functions and requirements, chassis lay out types, Loads acting on chassis, chassis members selection, frame materials, types of bodies, features of body, body structural requirements, body structural elements, design for body bending, design for body torsion, design for crashworthiness, design for vibration, design for vehicle and styling integration, material selection and mass estimation in preliminary design. (11+8)

STEERING AND SUSPENSION SYSTEM: Introduction, Functions and requirements, axles-live and dead axles, front axle and its types, stub axle and its types, steering mechanisms, arrangement of steering system, over steer and under steer, steering ratio calculation, steering gear box types, turning radius, center point steering, stub axle types, Wheel alignment, hydraulic power steering. SUSPENSION SYSTEM-Introduction, Functions, characteristics of good suspension system, suspension spring types-, types of suspension system, dampers, types, telescopic shock absorbers, air suspension, hydro elastic suspension, hydro pneumatic suspension system, active suspension system. (11+7)

TRANSMISSION SYSTEM: Clutch- role - types of clutches, single plate clutch, coil spring type and diaphragm spring type, multiple plate clutch, centrifugal clutch, calculation of torque transmission, over running clutch. Gear Box- Need for a gearbox, types of gear boxes, sliding mesh, constant mesh and synchromesh gear boxes, calculation of gear ratios, overdrives, transfer case and transaxles, propeller shaft drive, Hotchkiss drive, Torque tube drive, universal joints, trunnion type, ring type, flexible disc type, constant velocity joint types, Final Drive and Differential- need for final drive and differential, types of final drives, single reduction and double reduction final drives, differential and its types, conventional and non-slip differentials, rear axle and its types, fully floating, semi-float and three quarter floating axles. (11+8)

BRAKE SYSTEM, WHEELS AND TYRES: Introduction, principle, classifications, requirements, drum brake, disc brake, stopping distance calculations, weight transfer calculations, braking efficiency calculations, mechanical brake, hydraulic brakes, vacuum servo brakes, air brakes, air assisted hydraulic brakes, introduction to Anti-lock braking system. Wheels and Tyres- basic construction of wheel, hub and tyres, tyre requirements, interchangeability, passenger car and commercial vehicle requirements, bias ply and radial ply tyres, tubeless tyres, wheel balancing, tyre inflation, tyre wear and tyre rotation, quick change wheels, special wheels, run flat tyre. (12+7)

REFERENCES:

Total L: 45 + T: 30 = 75

18AE03 IC ENGINES AND EMISSIONS


REFERENCES:

18AE04 AUTOMOTIVE ELECTRONICS

OVERVIEW OF VEHICLE ELECTRONICS: Need for Electronics in Automotive Systems - Performance (speed, power, and torque), control (emission, fuel economy, drivability, and safety) & legislation (environmental legislation for pollution & safety norms). Overview of Vehicle Electronic Systems Basic electrical components and their operation in an automobile - power train subsystem (starting systems, charging systems Ignition systems, electronic fuel control), chassis subsystem (ABS, TCS, & ESP) – Comfort and safety subsystems (night vision, airbags, seatbelt tensioners, cruise control, Lane-departure Warning, parking).

ELECTRONIC ENGINE CONTROLS: Concept of an electronic engine control system, electronic fuel injection - throttle body fuel injection, multi point fuel injection, gasoline direct injection, common rail direct injection, electronic ignition control, engine mapping, on-board diagnostics – engine control module and power train control module.

SENSORS AND ACTUATORS: Classification of sensors, sensor for speed, throttle position, exhaust oxygen level, manifold pressure, crankshaft position, coolant temperature, exhaust temperature, air mass flow for engine application. Solenoids, stepper motors and relay.


REFERENCES:

18AE05 VEHICLE DEVELOPMENT PROCESS

OVERVIEW OF VEHICLE DEVELOPMENT PROCESS:

ENGINE DESIGN AND DEVELOPMENT: The process of designing an engine involves the selection of a basic engine type, the development of the engine layout and the selection of components. The design of an engine involves the selection of a basic engine type, the development of the engine layout and the selection of components. The design of an engine involves the selection of a basic engine type, the development of the engine layout and the selection of components.

ENGINE PERFORMANCE: The performance of an engine is determined by its design and operating conditions. The performance of an engine is determined by its design and operating conditions. The performance of an engine is determined by its design and operating conditions.

ENGINE MAINTENANCE: The maintenance of an engine involves the inspection, repair, and replacement of components. The maintenance of an engine involves the inspection, repair, and replacement of components. The maintenance of an engine involves the inspection, repair, and replacement of components.

ENGINE MANUFACTURING: The manufacturing of an engine involves the production of components and the assembly of the engine. The manufacturing of an engine involves the production of components and the assembly of the engine. The manufacturing of an engine involves the production of components and the assembly of the engine.

ENGINE TESTING: The testing of an engine involves the evaluation of its performance and durability. The testing of an engine involves the evaluation of its performance and durability. The testing of an engine involves the evaluation of its performance and durability.

ENGINE QUALITY CONTROL: The quality control of an engine involves the inspection and testing of components and the assembly of the engine. The quality control of an engine involves the inspection and testing of components and the assembly of the engine. The quality control of an engine involves the inspection and testing of components and the assembly of the engine.

ENGINE DISTRIBUTION: The distribution of an engine involves the transportation and storage of components and the assembly of the engine. The distribution of an engine involves the transportation and storage of components and the assembly of the engine. The distribution of an engine involves the transportation and storage of components and the assembly of the engine.

ENGINE SALES: The sales of an engine involves the marketing and distribution of components and the assembly of the engine. The sales of an engine involves the marketing and distribution of components and the assembly of the engine. The sales of an engine involves the marketing and distribution of components and the assembly of the engine.
VEHICLE DEVELOPMENT PROJECTS: An Overview, Categories of vehicle development projects, Platforms and model lines, The product evolution process (PEP), Vehicle project management, Aspects of international development projects. Cars that topped and cars that flopped, Factors of success in the automotive industry. Phases of the product evolution process. Initial phase, concept phase, series development phase, series support and further development. (12)

VIRTUAL CAR PROCESS: Building virtual cars, Geometric integration, further functional geometry evaluation, Virtual build groups. E/E system development: From machinery to E/E systems, Systems engineering processes. (11)

MANAGEMENT PROCESSES FOR COMPLETE VEHICLE DEVELOPMENT: Target management, Design problem management, Release and change management, Quality management. (11)

CUSTOMER RELEVANT COMPLETE VEHICLE CHARACTERISTICS: Registrability, Total vehicle costs, Design appeal, Cabin comfort, Infotainment, Agility, Passive safety, Theft deterrence, Reliability, Sustainability. Secondary complete vehicle characteristics, Production Integration, Service Integration. (11)

REFERENCES:

18AE51 AUTOMOTIVE ENGINEERING LABORATORY

0 0 4 2

In this practical course students will be provided with an insight into Automotive Systems and their functionalities using the following experiments. After this, students are expected to formulate and complete an activity of industrial relevance. The details like background, problem definition, state of technology/knowledge in that area are to be arrived based on a good literature review (5 latest papers). Results from the experiments and their interpretation with respect to the assumptions/background and a formal conclusion are expected in the report which is to be submitted at the end of the semester. The work is evaluated for the credit assigned.

1. Measurement of engine components and compression and vacuum test
2. Ignition system troubleshooting and onboard diagnosis
3. Servicing of clutches and gear boxes with Gear ratio calculation
4. Servicing of brake systems and brake bleeding
5. Servicing of Steering system and Ackermann steering verification
6. Chassis measurement and Servicing of suspension system
7. Wheel balancing & Wheel Alignment
8. Battery testing and Head light alignment
9. Servicing and testing of Starter motors and alternator.
10. Performance test on IC engines and emission measurement

Total P: 60

REFERENCE

II SEMESTER

18AE06 VEHICLE DYNAMICS

2 2 0 3

INTRODUCTION: Earth and vehicle coordinate system. Longitudinal, lateral and vertical vehicle dynamics. Dynamic axle loads. Road loads - Aerodynamic forces and moments, viscosity effects, separation and its control; aerodynamic lift and its control, ground effect, styling for minimum drag. Rolling resistance, grade loads. (8+7)

PERFORMANCE MODE: Acceleration - Free body diagram of accelerating vehicle, maximum transferable tractive force, gradability, Deceleration - free body diagram of decelerating vehicle, maximum decelerating rates, stopping distance, maximum braking force. Vehicle performance. (7+8)

RISE MODE: Pitch and bounce motion, oscillation centers, active and semi active suspension, orthogonality of mode shapes, modal analysis. Spring System - Requirements, sprung mass and un-sprung mass, wheel hop, shimmy, wheel wobble, choice of suspension spring rate, calculation of effective spring rate. Tyres - mechanics, stability of vehicle on slope, on curve and banked road. Quartet car and Half car modeling. (8+7)
HANDLING MODE: Vehicle control-low speed cornering and static steering-Ackerman steering geometry, steady-state cornering - steering factors, vehicle control parameters (under steer, neutral steer and over steer), roll steer, compliance steer, ride steer, slip angle steer, steady state handling-lateral acceleration gain, characteristic speed, yaw velocity gain, critical speed, effect on vehicle handling.

REFERENCES:

18AE07ENGINE COMPONENT DESIGN

REQUIREMENTS FOR ENGINE DESIGN: Arriving at the engine capacity from vehicle performance requirements – Design of Parts Working under alternating loads - Engine balancing - kinematics of crank mechanism - Forces acting on crank mechanism. (11+8)

DESIGN OF PISTON ASSEMBLY: Introduction- design of crown thickness- Empirical relationships- Design of CI and SI engine pistons-Compression ring design for CI and SI engine pistons- piston pin design for CI and SI engines- Design of connecting rod I section. (11+7)


DESIGN OF ENGINE SYSTEMS: Design of lubrication system elements - oil pump- oil cooler- design of cooling system components- water pump- cooling fan and radiator- computation air cooling surface. (12+7)

REFERENCES:

18AE08AUTOMOTIVE EMBEDDED SYSTEM

INTRODUCTION: Embedded Systems Definition - Components of embedded systems - Hardware Module - Microprocessor, microcontrollers, ARM Processor, on-chip peripherals - Program memory(PM), Data memory (DM), parallel port structures, timer, input capture & output compare units, ADC, PWM. (11)

INTEGRATED SYSTEMS: Introduction to an embedded board, Software module - IDE - Getting Started - Creating new project, creating new files, adding files to project, compile, build, debug and simulation of a project. Embedded system programming - Up-loaders, ISP, ROM emulators, in-circuit emulators. Debug Interfaces - BDM and JTAG. (11)

EMBEDDED RTOS: Comparison of conventional OS with RTOS. Tasks & task states (Pre-emptive & Non-pre-emptive, scheduler, interrupt – Interrupt latency and context switch latency) – Task, multi-tasking, task synchronization, inter-task communication, shared data problem and its prevention - Features of a typical embedded RTOS (µC/OS-II). (12)


REFERENCES:
INTRODUCTION AND MATHEMATICAL MODELLING: - Introduction to control systems, differential equations of physical systems, dynamics of robotic mechanisms, transfer functions, block diagram algebra, signal flow graphs, feedback and non-feedback systems, reduction of parameter variations, control over dynamics, control effects of disturbances signals, linearizing effects, regenerative feedback- linear approximation of nonlinear systems, stepper motor and hydraulic systems.

TIME RESPONSE AND STABILITY IN TIME DOMAIN: Standard test signals, time response of first order systems, time response of second-order systems, steady state errors and error constants, effects, effects of adding zero to systems, design specification of second order systems, design consideration for higher-order systems, performance indices, robotic control systems, state variable analysis, approximation of higher order systems by lower order systems, concept of stability, necessary conditions, Routh stability criterion, relative stability analysis.

FREQUENCY RESPONSE ANALYSIS AND STABILITY IN FREQUENCY DOMAIN: - correlation between time domain and frequency response, polar plots and bode plots, all-pass and minimum pass systems, experimental determination of transfer functions, log magnitude versus phase plots. Nyquist stability criterion, assessment of relative stability, closed loop frequency response, sensitivity analysis.

INTRODUCTION TO DESIGN AND STATE VARIABLE ANALYSIS AND DESIGN: -P, PI and PID controllers, cascade compensation in time domain and frequency, feedback compensation and robust control systems design- Concepts of state, state variables and state model, state models for linear continuous –time systems, state variables and linear discrete –time systems, solutions of state equations, concepts of controllability and observability, pole zero placement by state feedback.

REFERENCES:

18AE52 AUTOMOTIVE COMPUTER AIDED ENGINEERING LABORATORY

In this practical course students will be provided with a comprehensive practical exposure to Automotive Computer Aided Engineering and its functionalities using the following experiments. After this, students are expected to formulate and complete an activity of industrial relevance. The details like background, problem definition, state of technology/knowledge in that area are to be arrived based on a good literature review (5 latest papers). Results from the experiments and their interpretation with respect to the assumptions/background and a formal conclusion are expected in the report which is to be submitted at the end of the semester. The work is evaluated for the credit assigned.

1. Modeling of Automotive Component and Assemblies
2. Analysis of Automotive Component and Assemblies
3. Simulation of Automotive Component and Assemblies

AUTOMOTIVE ANALYSIS
1. Engine Components
2. Cooling System
3. Power train
4. Steering System
5. Brake System
6. Suspension System
7. Chassis Frame
8. Aerodynamic forces
9. Structural analysis
10. Safety Analysis

REFERENCE:
The student will make at least four one or half day Industry visits and technical presentations. The same will be assessed by a committee appointed by the department. The students are expected to submit a report at the end of the semester covering the various aspects of his/her presentation together with the observation in industry visits. A quiz covering the above will be held at the end of the semester.

Total P: 60

III SEMESTER

18AE71 PROJECT WORK I

- Identification of a current industry problem in thrust areas
- Developing a mathematical model for solving the above problem
- Finalization of system requirements and specification
- Proposing different solutions for the problems based on literature survey
- Future trends in providing alternate solutions
- Consolidated report preparation of the above

Total P: 90

IV SEMESTER

18AE72 PROJECT WORK II

The project work involves the following:
- Preparing a project brief proposal including
  - Problem identification
  - A statement of system / process specification proposed to be developed (Block diagram / concept tree)
  - List of possible solutions including alternative and constraints
  - Cost benefit analysis
  - Time Line of activities
- A report highlighting the design finalization (based on functional requirements & standards (if any))
- A presentation including the following:
  - Implementation Phase (Hardware / Software / both)
  - Testing & Validation of the developed system
  - Learning in the Project
- Consolidated project report preparation

Total P: 420

ELECTIVE THEORY COURSES

AUTOMOTIVE SAFETY STREAM

18AE10 ELECTRIC DRIVES AND STORAGE SYSTEMS


ENERGY SOURCES FOR ELECTRIC AND HYBRID VEHICLES: plug-in hybrid electric vehicle, and electric vehicle Li-ion batteries- Cell designs- Battery pack design- Safety requirements- Components of HV battery packs- Requirements of HV battery packs- Testing procedures for EV batteries

BATTERY CHARGING STRATEGIES FOR ELECTRIC VEHICLES: Introduction-Charging algorithms for a single battery-Balancing methods for battery pack charging-Charging infrastructure.
BATTERY MANAGEMENT SYSTEMS: Topology of BMS-BMS representation - Data management and network- SoC and SoH - Battery balancing- Safety aspects of BMSs-BMS standard.

REFERENCES:

18AE11 AUTOMATIC AND AUTOMATED MANUAL TRANSMISSION

HYDRODYNAMIC DRIVES: Principle of fluid coupling, construction, operation and characteristics, fluid coupling with conventional gear boxes. Introduction to torque converters, comparison between fluid coupling and torque converters, performance characteristics, slip, principles of torque multiplication, types of torque converters.


HYDROSTATIC DRIVES: Principles of hydrostatic drives, different systems of hydrostatic drives, fixed displacement pump and fixed displacement motor, variable displacement pump and fixed displacement motor, fixed displacement pump and variable displacement motor, variable displacement pump and variable displacement motor, applications, plunger type pump and plunger type motor, advantages and limitations, typical hydrostatic drives.


REFERENCES:

18AE12 AUTOMOTIVE INFOTRONICS

INTRODUCTION: Driver information, driver perception, driver convenience, driver monitoring, general vehicle control, longitudinal and lateral control, collision avoidance and vehicle monitoring.

SAFETY SYSTEMS: Active and passive safety, airbags, seat belt tightening system, forward collision warning systems, Radar monitoring system, Ultrasonic sensor, child lock, anti lock braking systems, EBD, ESP, traction control system and lane departure warning system.

COMFORT & SECURITY SYSTEMS: Adaptive cruise control system, active suspension system, power steering, collapsible and tilttable steering column and power windows, Adaptive lighting system, Security - Anti theft technologies – mechanical, electromechanical and electronic immobilizers, alarm system, stolen vehicle tracking system, remote keyless entry, smart card system and number plate coding.

New car Assessment Program: Body parts shell for safety–NCAP and Global Norms, Frontal and offset frontal Crash requirements, Safety for seating and seat belt anchorages; Head impact and Injury prevention.

REFERENCES:
18AE13 AUTOMOTIVE ERGONOMICS AND SAFETY

INTRODUCTION: Definition, human technological system, multidisciplinary engineering approach, human – machine system, manual, mechanical, automated system, human system reliability, conceptual design, advanced development, detailed design and development, human system modeling. INPUT: Input and processing, text, graphics, symbols, codes, visual display of dynamic information, auditory, tactial, displays, speech communications. biomechanics, biothermodynamics and bioenergetics. (12)

VEHICLE ERGONOMICS: Introduction, seating dimensions, interior ergonomics, ergonomics system design, seat comfort, suspension seats, split frame seating, back passion reducers, dash board instruments, electronic displays, commercial vehicle cabin ergonomics, mechanical package layout, goods vehicle layout. (11)

ENVIRONMENTAL CONDITIONS: Illumination, heat ventilation and air conditioning, noise, motion, speed and acceleration, sound, vibration. (11)

HUMAN FACTORS APPLICATIONS: Human error, accidents, human factors and the automobile, organizational and social aspects, steps according to ISO/DIS6385, OSHA’s approach, virtual environments. SAFETY: Seat belt, air bag, collapsable steering, warning systems, ABS braking system, collision safety systems, global safety standards in automotive applications. (11)

REFERENCES:

Total L: 45

18AE14 AUTONOMOUS VEHICLES

INTRODUCTION: Advance driver assistance systems, LIDAR, RADAR, Image processing, Navigation (GPS & GIS) systems, Adaptive cruise control systems, lane departure warning systems, automatic emergency braking systems- night vision systems-autopilot-SAE international level of driving automation- V2V, V2I, Nokia Here digital maps- Communication protocols overview-case study-DARPA and google waymo. (14)

CONNECTED FLEET SYSTEMS: Platoon, Bluetooth, Wi-Fi connectivity, Information, Advisory and Warning, Li-fi connectivity, automated highway systems-aerodynamics performance, fleet testing and evaluation project. (11)


AUTOPILOT & IOTS IMPACT ON MOBILITY: Liability- vehicle intelligence- vehicle internet security- Crash Imminent Braking- communication Standard-Distributed System Architecture of Autonomous Vehicles and Real-Monocular camera, Real time perception control (Neural Network), disagreement notification- temporal difference input to neural network. (10)

REFERENCES:

Total L: 45

18AE15 AUTOMOTIVE SAFETY SYSTEM

INTRODUCTION: Driver information, driver perception, driver convenience, driver monitoring, general vehicle control, longitudinal and lateral control, collision avoidance and vehicle monitoring. (11)

SAFETY SYSTEMS: Active and passive safety, airbags, seat belt tightening system, forward collision warning systems, child lock,

SENSORS, ACTUATORS AND CONTROL UNIT: Sensors for measuring crankshaft speed, camshaft position, Mass air flow (MAF), exhaust gas oxygen, throttle plate angular position, coolant temperature, intake air temperature, manifold absolute pressure (MAP), differential exhaust gas pressure, Nitric Oxide. Actuators for controlling EGR, Fuel Injection Quantity (Injector Solenoid and Piezo), Air control via throttle control, EGR control via EGR valve, variable valve timing and lift control, Turbo-charger control via waste gate control.

ENGINE CONCEPTS FOR PERFORMANCE AND EMISSION CONTROL: Gasoline Engine: MPFI and GDI System – Working of MPFI and GDI systems, Lambda control with three-way catalyst, Throttle control, Variable valve timing and lift control, Engine Downsizing via Turbo & Compressor Control, NOx control (NOx storage catalyst and Selective Catalytic Reduction), Particulate control (Particulate Trap and Regeneration).

DIESEL ENGINE: CRDI System – Fuel Injection control for engine performance optimization (Speed, Torque, Vibration and Noise), NOx control via Injection control, EGR control, NOx storage catalyst, Selective Catalyst Reduction. Particulate control via particulate trap and regeneration.

REFERENCES:
WAVEFORM GENERATORS, A/D AND D/A CONVERTORS: Comparator and its application, Regenerative comparator and square wave generator (Astablemultivibrator), Basic DAC techniques –Weighted resistor, R-2R ladder and inverted R-2R ladder, ADC-Direct Type ADC’s –Flash ADC, Successive approximation ADC. (11)

REFERENCES:

18AE18 VEHICLE DIAGNOSTICS

ON AND OFF-BOARD DIAGNOSTICS: Introduction to fault diagnosis and oscilloscope diagnostics, mechanical and electrical diagnostic techniques, sensors and actuators associated with oscilloscope diagnostics, faults Codes, Scanners/Fault Code Readers, Engine Analysers, On-board diagnostics various perspectives, Petrol/Gasoline On-board diagnostics, On-board sensors and actuators. (11)

ENGINE SYSTEM DIAGNOSIS: Introduction to engine systems diagnostics, engine operation and fuel system, ignition system and emission system, fuel injection, starting and charging system, power flow control and energy efficiency analysis, engine management and fault-finding information, air supply, exhaust system, cooling and lubrication system. (11)

CHASSIS AND BRAKE SYSTEM DIAGNOSIS: Introduction to chassis diagnostics, anti-lock braking system diagnostics, traction control system diagnostics, steering and tires, transmission systems diagnostics, diagnostics on steering and tires. (11)

ELECTRICAL SYSTEMS DIAGNOSIS: Introduction to electronic components and circuits, multiplexing and de multiplexing, lighting system faults and auxiliary faults, in-car entertainment security and communications implementation, body-electrical systems, instruments system faults, heating ventilation and air conditioning cruise control, air bags and belt tensioners. (12)

REFERENCES:

18AE19 AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS

BATTERIES AND IGNITION SYSTEM: Lead acid and alkaline batteries, construction and working, battery rating, battery charging methods, testing and maintenance. Ignition system-Introduction - Construction and working of magneto coil and battery coil ignition systems, spark plug types, spark advance mechanisms, electronic ignition systems - Transistorized ignition system, solid state ignition systems, capacitor discharge ignition system and distributor less ignition system. (11)

STARTING SYSTEM AND CHARGING SYSTEM - Principle, construction and working of starter motor, working of different starter drive units CHARGING SYSTEM: Alternators – Principle, construction and working – Regulators, Introduction to Start / Stop system, integrated starter generator (ISA/ISG) (11)

SENSORS AND ACTUATORS: Mass air flow (MAF), exhaust gas oxygen, throttle plate angular position, crankshaft angular position/rpm, coolant temperature, intake air temperature, manifold absolute pressure (MAP), differential exhaust gas pressure, vehicle speed, pickups sensors, exhaust gas recirculation sensors, electric fuel pump motor characteristics, piezoelectric stack injectors and solenoids for injection systems. (11)

ELECTRONIC ENGINE CONTROL - Electronic diesel control -Comparison indirect and direct injection- mechanical and hydraulic actuated EDC - In-line fuel-injection pumps, helix and port controlled axial piston distributor, solenoid valve control, unit injectors, common rail systems, data processing, lambda closed loop control, torque-controlled EDC systems, control and triggering of actuators. Electronic gasoline control: Battery ignition system-open loop and closed loop systems, mono point, multi point, gasoline direct injection systems, air assisted systems, principles and features of Bosch jetronic systems, idle speed, knock and spark timing control, magnetostrictive ignition, capacitor discharge ignition, solid state and transistor ignition, distributor less ignition. (12)

REFERENCES:

DESIGN ENGINEERING STREAM ELECTIVES

18AE20 FINITE ELEMENT ANALYSIS 3 0 0 3


HEAT TRANSFER ANALYSIS: Basic differential equations of heat transfer, one dimensional and two-dimensional finite element formulation using variational and Galerkin’s method, one dimensional steady state heat transfer problems involving conduction and convection. Analysis of tapered fin, Formulation of thermal stress problems and examples, transient thermal analysis.  


Total L: 45

REFERENCES:

18AE21 AERODYNAMICS OF ROAD VEHICLES 3 0 0 3


SHAPE OPTIMIZATION OF CARS: Front end shape modifications, front and rear wind shield angle, A and C pillar, front and rear spoilers, Roof modifications, rear end shape modifications - boat tailing, hatch back, fast back and square back, dust flow patterns at the rear, effects of gap configuration, effect of fasteners.  

VEHICLE HANDLING: Origin of forces and moments on a vehicle, lateral stability, methods to calculate forces and moments - vehicle dynamics under side force and winds, steady and cornering effect - steering angle and slip angle, under steer and over steer gradient, suspension effects on cornering, roll moments on front and rear axles, dirt accumulation on the vehicle, wind noise, drag reduction in commercial vehicles.  

WIND TUNNELS FOR AUTOMOTIVE AERODYNAMICS: Introduction, principle of wind tunnel technology, limitation of simulation, stress with scale models, full scale wind tunnels, measurement techniques, equipment and transducers, road testing methods, numerical methods.  

Total L: 45

REFERENCES:
INTRODUCTION: Application areas of CFD, Basic concepts of fluid flow - governing equations, conservation of mass, momentum and energy – Navier-stokes and energy equation for Newtonian fluid, Mathematical classification of flow - hyperbolic, parabolic, elliptic and mixed flow types. 


TURBULENCE MODELING AND CASE STUDIES: Turbulence energy equation- one-equation model, the k-ω model, the k-ε model. Modeling and analysis of heat transfer, fluid flow and automobile components using CFD packages.

REFERENCES:

18AE23 AUTOMOTIVE SYSTEM DESIGN AND SIMULATION


Steering system and Road modeling: Steering system forces and moments calculation- EPS motor torque requirement and influence different parameters – parking torque estimation- dynamics of rack and pinion steering – concept of road modeling - Deterministic Profiles – Random profiles.

Suspension and tire modeling: Quarter car model - Kinematics of a Double Wishbone Suspension - Modeling Aspects - Constraint Equations - Spring Damper in Series tire modeling – Pacejka magic formula- brush and Dugoff model- Introduction to full car model with 16 DoF.

REFERENCES:

18AE24 DESIGN FOR MANUFACTURE AND ASSEMBLY

DFMA TOOLS: Traditional design and manufacture vs concurrent engineering, poka-yoke, lean principles, six sigma concepts, DFMA as the tool for concurrent engineering, Process capability, process capability metrics, Cp, Cpk, cost aspects, Design for assembly (DFA), Design for the Environment (DFE) - environmental objectives, global issues, regional and local issues-basic DFE methods-design guidelines-example application.
TOLERANCE ANALYSIS: Geometric tolerancing for manufacture as per Indian standards and ASME Y 14.5 standard, surface finish, review of relationship between attainable tolerance grades and different machining processes. Cumulative effect of tolerances, dimensional chain analysis - equivalent tolerances method, equivalent standard tolerance grade method, equivalent influence method. Limits and fits, interchangeable part manufacture. Selective assembly. (11)

DATUM SYSTEMS AND TRUE POSITION THEORY: Degrees of freedom, grouped datum systems - different types, two and three mutually perpendicular grouped datum planes; Grouped datum system with spigot and recess, pin and hole; Grouped datum system with spigot - recess pair and tongue - slot pair - computation of translational and rotational accuracy, geometric analysis and applications. True position theory - comparison between coordinate and conventional method of feature location tolerancing and true position tolerancing, virtual size concept, floating and fixed fasteners, projected tolerance zone, zero true position tolerance, compound assembly. Functional inspection techniques using CMM and paper layout gauging. (11)

REDESIGN, TOLERANCE CHARTING: Redesign of castings based on parting line considerations, minimising core requirements, redesigning cast members using weldments, design guidelines for welding. Redesign of components to facilitate machining. Tolerance charting - operation sequence for typical shaft type of components, preparation of process drawings for different operations, tolerance worksheets and centrality analysis, examples. (11)

REFERENCES:

18AE25 AUTOMOTIVE POWERTRAIN DESIGN

CYLINDER AND PISTON: Materials for cylinder and piston. Analysis of forces. Design procedure for cylinder, piston, piston rings and piston pin. (11)

CONNECTING ROD: Materials for connecting rod and crank shaft. Analysis of forces. Design procedure for connecting rod small end, big end bearings and middle portion. Design procedure for crankpin, web and main bearing of crank shaft. (12)

VALVE AND VALVE ACTUATING MECHANISM: Materials. Design of inlet and outlet valves, valve springs, rocker arm, tappet, Cam, camshaft. (11)


REFERENCES:

Automotive Manufacturing Stream Electives

18AE26 ADVANCED MANUFACTURING PROCESSES

SURFACE TREATMENT: Scope, Cleaners, Methods of cleaning, Surface coating types, and ceramic and organic methods of coating, economics of coating. Electro forming, Chemical vapour deposition, thermal spraying, Ion implantation, diffusion coating, Diamond coating and cladding. (11)


PROCESSING OF CERAMICS: Applications, characteristics, classification. Processing of particulate ceramics, Powder preparations, consolidation, Drying, sintering, Hot compaction, Area of application, finishing of ceramics. Processing of Composites:
Composite layers, particulate and fiber reinforced composites, elastomers, reinforced plastics, MMC, CMC, polymer matrix composites.

Fabrication of microelectronic devices: Crystal growth and wafer preparation, film deposition, oxidation, lithography, bonding and packaging, reliability and yield, printed circuit boards, computer aided design in microelectronics, surface mount technology, integrated circuit economics. Manufacturing, nanotechnology, and micromachining, high speed machining.

**REFERENCES:**

**18AE27LEAN MANUFACTURING**

**INTRODUCTION:** History - Objectives - Implications of lean. Traditional vs. mass production vs. lean manufacturing vs. smart manufacturing. Single variant vs. flexible mixed model support. Lean culture. Paper Lean vs. IT based Lean. LEAN CONCEPTS: Five Key principles - Value creation - 3M - Takt time.


**LEAN IMPLEMENTATION:** Roadmap to implement lean project - Hoshin planning. RECONCILING WITH OTHER SYSTEMS: Lean six sigma - PDM, ERP, ERP II and PLM - Lean with ISO9001:2000. Industry 4.0/5.0.

**REFERENCES:**

**18AE28LEAN SIX SIGMA**

**INTRODUCTION:** Background - Six sigma definition - Six sigma vs. TQM - Traditional project vs. Lean six sigma project. CONCEPT: Four keys, Five laws - COPQ - Total quality cost - Importance of Value stream mapping - Types of Lean six sigma: DMAIC vs DFSS. Industry culture. Selection of team members. Characteristics of team members.


**DESIGN FOR SIX SIGMA (DFSS) PROJECT:** DFSS methodologies - QFD - Theory of Inventive Problem Solving (TRIZ) - FMEA - Design for DFX – Robust design and process.

**LEAN SIX SIGMA IMPLEMENTATION:** Roadmap to implement or execute a lean six sigma project. Software tools available for DMAIC and/or DFSS.

**REFERENCES:**

18AE29 AUTOMOTIVE MATERIALS AND METALLURGY

METALLIC MATERIALS AND THEIR PROCESSING: ferrous and non ferrous materials properties, alloying elements and their effects, characteristics of metallic materials such as castability, machinability, hardenability, formability, weldability, etc. Processing of metallic materials – casting, forming, fabrication and heat treatments. Micro alloyed, high strength low alloy steel - High strength Steels (HSS), Advanced High Strength Steels (AHSS), Ultra high strength Steels (UHSS), and developments in non ferrous alloys for automotive industry.


ADVANCED MATERIALS AND THEIR PROCESSING: composite materials – type, application, properties and processing of composite materials. Composites for automotive industry. Light weight materials Carbon fiber composites, Natural fibers, refractory metals, SMART Materials - shape memory alloys (SMA), Piezo-electric materials, MEMS, Metallic glass-Quasi crystal and Nano crystalline materials, metal foams, etc., Advanced processing of materials – Powder metallurgy (hot isostatic & cold isostatic), Hydroforming, Laser welding techniques, Induction heating, etc.,


REFERENCES:

Total L: 45

Thermal Engineering Stream Electives

18AE30 EMISSION, NOISE, VIBRATION AND HARSHNESS CONTROL

Emission: Introduction - Types and causes of emission –SI and CI emission - Formation mechanisms- chemistry of emission- emission testing methods- engine design and operating parameters on emission- emission standards.

Noise fundamentals and Instrumentation techniques: Sound propagation, quantification of sound - frequency and wave length, sound pressure level, sound intensity level, vehicle noise specifications & standards, noise induced hearing losses. Exterior noise sources, Interior noise sources. Microphones & calibrators, Excitation devices, frequency analysis, sound pressure measurement, sound intensity measurement, sound intensity probes, data acquisition system, digital signal processing, semi-anechoic rooms.


Vibration fundamentals and Instrumentation techniques : Introduction, elements of vibration, source of vibration, types of vibration, transient and steady state response of one degree of freedom system applied to vehicle systems, multi degree of freedom system (MDOF), Undamped& damped vibrations, Vibration transducers, FFT analyser.

REFERENCE:

Total L: 45


REFERENCES:

NEED FOR ALTERNATIVE FUELS: An introduction to hydrocarbon fuels, estimate of petroleum reserve and availability, Petroleum refining process, Physio-chemical characteristics of fuels, fuel additives, Need for alternative fuels, applications, types, study of availability, manufacture, storage, handling and dispensing, safety aspects.


TYPES OF ALTERNATIVE FUELS: Alcohol fuels - ethanol & methanol, Vegetable oils, Fuel composition, Fuel induction techniques, Blending and fumigation of fuels, applications to engines. LPG and LNG, CNG, Producer gas, components, mixtures and kits, fuel supply system, Hydrogen combustion characteristics, safety aspects and system development, HCNG, Fuel cells, Introduction to Synthetic fuels: GTL, BTL.

BIOFUELS: Oxygenated fuels, Biodiesel formulation techniques, Transesterification, Application in diesel engines, DME (Dimethyl ether), DEE (Diethyl ether), properties, fuel injection consideration. Biomass: generation, characterization, use as energy source, Biogas: aerobic and anaerobic bio-conversion processes, microbial reactions, purification, properties of biogas (composition and calorific value), Storage and enrichment.

REFERENCES:
FUNDAMENTALS: Terminology, design factors and concepts related to air conditioning & refrigeration systems - Construction and Working principles of Thermostatic Expansion valve and Orifice tube-based system- Heating system types -detailed study of HVAC components like compressor, evaporator, condenser, TXV, orifice tube, Receiver-drier, heater core etc. Location of air conditioning components & refrigeration components in a vehicle.

REFRIGERANTS, AIR MANAGEMENT AND CONTROL SYSTEM SYSTEMS: Refrigerants: Temperature and pressure relation, Properties of R-12 and R134a- refrigerant oil. Simple problems -Containers - Handling refrigerants - Tapping into the refrigerant container - Ozone Layer Depletion. Air management system: Air routing for manual, semi and automatic system- cases and ducts- Air distribution, control head and doors- Defrost system Block diagram - types of Sensors and Actuators, - Control Logic Electrical wiring diagram of manual and automatic system - multiplexing between BCM and PCM- control of compressor clutch, blower motor etc.- diagnostics tools and features.

DESIGN OF AIR-CONDITIONING COMPONENTS: Modeling of Fixed and variable Displacement type compressor, evaporator modeling – heat transfer correlations for the fluids inside the evaporator, analysis of evaporator frosting- condenser modeling - improvement of refrigerant flow control method.

DIAGNOSIS AND SERVICES: Air conditioning & refrigeration system diagnosis based on temperature and pressure measurements, sight glass, sound etc. -refrigerant leak detection- Trouble shooting and Servicing of compressor, evaporator, condenser, heater core. Air routing system service.

REFERENCES:

Total L: 45

COMBUSTION PRINCIPLES: Thermodynamics - concepts of combustion – combustion equations - heat of combustion theoretical flame temperature - chemical equilibrium and dissociation, equilibrium constant for ideal gas mixture. Chemical thermodynamics, chemical reaction, fuels and combustion, enthalpy of formation and enthalpy of combustion, 1st law analysis of reacting systems, adiabatic flame temperature of different fuels.

FUELS AND CHEMICAL KINETICS: Flame stability, combustion mechanisms of solid liquid and gaseous fuels. Theories of combustion - pre-flame velocities - reaction rates - laminar and turbulent flame propagation in engines- reaction mechanisms of hydrogen and hydrocarbon combustion.


COMBUSTION IN CI ENGINES: Various stages of combustion - vaporization of fuel droplets and spray formation – air motion - swirl measurement - delay period correlations and affecting variables, diesel knock and engine variables, features and design considerations of combustion chambers - swirl, squish and tumble Flow visualization and modelling.

REFERENCES:

Total L: 45

COMBUSTION AND STOICHIOMETRY: Reactive processes, Heat of reaction, measurement of URP, measurement of HRP.
Introduction - combustion equation for hydrocarbon fuels. Calculation of minimum air, excess air and stoichiometric air required for combustion. Conversion of volumetric analysis to mass analysis. Introduction, complete combustion in C-H-N-O systems, constant volume adiabatic combustion, constant pressure adiabatic combustion, calculation of adiabatic flame temperature, isentropic changes of state.

COMPUTER SIMULATION OF SI ENGINE WITH FUEL AIR CYCLE: SI Engine simulation with air as working medium, deviation between actual and ideal cycle. Fuel air cycle analysis - Temperature drop due to fuel vaporization, full throttle operation, work output and efficiency calculation, part-throttle operation, engine performance at part throttle, super charged operation. SI Engines simulation with progressive combustion. Wiebe’s law combustion analysis, validation of the computer code, engine performance simulation, pressure crank angle diagram, brake power, brake thermal efficiency, effect of speed on performance.


REFERENCES:

18AE36 INSTRUMENTATION FOR THERMAL SYSTEMS


MEASUREMENT OF PHYSICAL QUANTITIES: Measurement of thermo-physical properties, instruments for measuring temperature, pressure and flow, use of sensors for physical variables.

MEASUREMENT OF PHYSICAL QUANTITIES: Measurement of thermo-physical properties, instruments for measuring temperature, pressure and flow, use of sensors for physical variables.

REFERENCES:

18AE37 THERMAL MANAGEMENT OF HYBRID SYSTEMS

INTRODUCTION: First Law of Thermodynamics for open and closed systems; internal energy, enthalpy, and specific heat - Second Law of Thermodynamics for closed systems; Thermodynamic equations, Gibbs function - Fluid mechanics: laminar vs. turbulent flow, internal flow relationships, Navier Stokes equations - Heat transfer: simple conduction, convection, and radiation relationships; Nusselt number relationships for convective heat transfer; energy equation.


THERMAL MANAGEMENT FOR BATTERIES AND POWER ELECTRONICS: Introduction - Thermal control in vehicular battery systems: battery performance degradation at low and high temperatures - Passive, active, liquid, air thermal control system configurations for HEV and EV applications - Battery Heat Transfer - Introduction to battery modeling: tracking current demand, voltage, and State of Charge as functions of time for given drive cycles - Development of thermodynamic relationships for cell heat
THERMAL MANAGEMENT SYSTEMS: Overall energy balance to determine required flowrates - Determination of convection and friction coefficients for air and liquid systems in various geometric configurations: flow around cylinders, flow between plates, flow through channels - Development of a complete thermal system model and parametric study results - Temperature control and heat transfer using phase change materials - Thermal Management of Power Electronics.

REFERENCES:

18AE38 FUEL CELL VEHICLES

Introduction and Thermodynamics of fuel cells: Introduction-working and types of fuel cell-Low, medium and high temperature fuel cell. Enthalpy change of a reacting system, systematic Gibbs free energy, Ideal efficiency of the energy conversion, energy balance in fuel cells. First and second law of thermodynamics for fuel cells.

Electrochemistry of fuel cells: Nernst equation, relation of the fuel consumption versus current output, stoichiometric coefficients and utilization percentages of the fuel and oxygen, mass flow rate calculation for fuel and oxygen in single cell and fuel cell stack, total voltage and current for fuel cells in parallel and series connection, over-potential and polarizations, generous issues - water flooding and water management.

FUEL CELL COMPONENTS AND FUELING: Material for conventional and new catalysts for MEA, Gas diffusion layer - Types and significance, various flow field design and their impact on performance. Fuel cell performance characteristics - Current/voltage, voltage efficiency and power density, Ohmic resistance, Kinetic performance, mass transfer effects, fuel cell stacks, bi-polar plate, humidifiers and cooling plates. Hydrogen generation and storage technologies - various methods and their influences.


REFERENCES:

OTHER ELECTIVES

TRACTORS AND GRADERS: Tractors - General description, specification and functions, light, medium and heavy wheeled tractors, crawler tracks mounted / wheeled - Bull dozers, till dozers and angle dozers, front end loaders, factors affecting efficiency of output of tractors, simple problems, merits and demerits. Graders -Description, specification of tractor towed graders and motor graders, classification and functions of graders, functional details of spreading, mixing, ditching, bank sloping, snow removal, stripping, scarifying, and finishing, elementary details of transmission system (coupling, clutches, gear box, driving axles, propeller shafts), running gear and operating equipment air braking system; hydraulic system and its components, steering system of lights, medium and heavy graders, merits and limitations of graders.

ROOTERS, SCARIFIERS AND SCRAPERS: General description, specification and functions, tractor towed rooters and scarifiers - Heavy duty, light duty. General description, specification and functions, tractor towed and motorized scrapers, scraper work in cutting, cambering, side hill cutting, spreading on embankments, compaction of fill merits and demerits.
CRANES, EXCAVATORS AND COMPACTION VEHICLES: General description, specifications and functions, excavator mounted cranes, mobile cranes with strut and cantilever type jibs, tractor towed and tractor mounted cranes. General description, specification and functions, classification based on attachments, face shovel, drag shovel, hoe, drag-line and grab or clam shell, advantages and limitations, Compaction Vehicles - General description, specification and functions, smooth wheeled rollers, pneumatic tired rollers, agricultural Rollers, sheep’s foot rollers, vibrating compactors.


REFERENCES:

18AE40 VEHICLE TESTING

3 0 0 3


SUSPENSION AND STABILITY FOR DIRECTIONAL CONTROL: Measurement of dimensional and geometric characteristics, measurement of centre of gravity position, measurement of moments and products of inertia, measurement of suspension kinematic characteristics, measurement of suspension elastic and coulomb friction characteristics, measurement of shock absorber characteristics.

STEERING AND BRAKING SYSTEM TESTING: Analysis of constant radius test, constant steer angle test, constant speed variable radius test, constant speed variable steer angle test, response gain test. Dynamic cornering fatigue, dynamic radial fatigue tests – procedure, bending moment and radial load calculations. Impact test – road hazard impact test for wheel and tyre assemblies, test procedures, failure criteria and performance criteria. Bumpers - types of tests, pendulum test, fixed collision barrier test, procedure, performance criteria. Air and hydraulic brake test, air brake actuator, valves test, performance requirements.

VEHICLE SIMULATION AND TESTING: Fault insertion testing in system model - brake fluid leakage test in from single to all wheels – steering – vehicle in loop testing – braking test on split \[ \text{conditions}. \] Traction loss and roll instability simulation.

REFERENCES:

18AE41 OPTIMIZATION TECHNIQUES

3 0 0 3


Advanced Topics in Linear Programming: Revised Simplex Method- Integer programming- Traveling salesman problem- Goal programming.


REFERENCES:

18AE42 AUTOMOTIVE PLM

MOTIVATION AND INTRODUCTION: e-commerce, B to B, B to C forms of business, extended enterprise, concepts in PDM - product life cycle, business objects, work flows, versions, views, product structure, change processes, work list, information flow model in product development, engineering bill of materials and manufacturing bill of materials. (12)

COMPONENTS OF PLM SOLUTIONS: Object oriented approach in product development solutions, phase gate process in product design - disparate databases and connectivity, use of EAI technology (middleware) - cases for preparation of combined BOM and other reports. Component supplier management and sourcing. (11)

PRODUCT VISUALISATION: CAD neutral environment and visualization of products, standard softwares, use of visualization in several stages of lifecycle, reviews, mark up - case studies. Role of PLM in industries: (like auto, aero, electronic) - other possible sectors, ten step approach PLM, benefits of PLM. (11)

Details of Module: Details of modules in a PDM/PLM software, basics on customization and implementation of automotive PDM/PLM software. (11)

REFERENCES:

18AE43 AUTOMOTIVE ERGONOMICS

INTRODUCTION: Definition, human technological system, multidisciplinary engineering approach, human – machine system, manual, mechanical, automated system, human system reliability, conceptual design, advanced development, detailed design and development, human system modeling. INPUT: Input and processing, text, graphics, symbols, codes, visual display of dynamic information, auditory, tactual, displays, speech communications. biomechanics, biothermodynamics and bioenergetics. (12)

VEHICLE ERGONOMICS: Introduction, seating dimensions, interior ergonomics, ergonomics system design, seat comfort, suspension seats, split frame seating, back passion reducers, dash board instruments, electronic displays, commercial vehicle cabin ergonomics, mechanical package layout, goods vehicle layout. (11)

ENVIRONMENTAL CONDITIONS: Illumination, heat ventilation and air conditioning, noise, motion, speed and acceleration, sound, vibration. (11)

HUMAN FACTORS APPLICATIONS: Human error, accidents, human factors and the automobile, organizational and social aspects, steps according to ISO/DIS6385, OSHA’s approach, virtual environments. SAFETY: Seat belt, air bag, collapsible steering, warning systems, ABS braking system, collision safety systems, global safety standards in automotive applications. (11)

REFERENCES:

ELECTIVE LABORATORY COURSES

18AE53 AUTOMOTIVE STYLING AND DESIGN LABORATORY
Description: In this practical course students will be provided with a comprehensive practical exposure to Automotive Styling and Design Laboratory and their functionalities using the following experiments. After this, students are expected to formulate and complete an activity of industrial relevance. The details like background, problem definition, state of technology/knowledge in that area are to be arrived based on a good literature review (5 latest papers). Results from the experiments and their interpretation with respect to the assumptions/background and a formal conclusion are expected in the report which is to be submitted at the end of the semester. The work is evaluated for the credit assigned. Expected hours needed for this work is 20 hours.

1. Automotive sketching
2. Automotive packaging design
3. Automotive class A modeling
4. Automotive Exterior design
5. Automotive Interior design

Total P: 30

REFERENCE:  

15AE54 AUTOMOTIVE EMBEDDED SYSTEMS LABORATORY

Description: In this practical course students will be provided with a comprehensive practical exposure to Automotive Embedded Systems Laboratory and their functionalities using the following experiments. After this, students are expected to formulate and complete an activity of industrial relevance. The details like background, problem definition, state of technology/knowledge in that area are to be arrived based on a good literature review (5 latest papers). Results from the experiments and their interpretation with respect to the assumptions/background and a formal conclusion are expected in the report which is to be submitted at the end of the semester. The work is evaluated for the credit assigned. Expected hours needed for this work is 20 hours.

1. Study of an Integrated Development Environment
2. Simulation of Automotive Sensors and Actuators
3. Interfacing of Sensors and Actuators
4. Code conversion and Waveform (square and rectangle) generation
5. Simulation of automotive lighting system.

Total P: 30

REFERENCE:  

18AE55 MODELING AND SIMULATION LABORATORY

Description: In this practical course students will be provided with a comprehensive practical exposure to Modelling and Simulation Laboratory and their functionalities using the following experiments. After this, students are expected to formulate and complete an activity of industrial relevance. The details like background, problem definition, state of technology/knowledge in that area are to be arrived based on a good literature review (5 latest papers). Results from the experiments and their interpretation with respect to the assumptions/background and a formal conclusion are expected in the report which is to be submitted at the end of the semester. The work is evaluated for the credit assigned. Expected hours needed for this work is 20 hours.

Experiments:
1. Tire characteristics modeling using Pacejaka's Magic formula
2. Quarter Car suspension system modeling
3. Dynamics of a Simple Steering System Model
4. Double Wishbone Suspension Kinematic Analysis
5. Nonlinear Damper Characteristics simulation
6. Piston speed and acceleration simulation
7. Simulation of engine kinematic forces
8. Simplified model for Four cylinder CI engine torque
9. Simplified model for Four cylinder SI engine torque
10. Roll centre variation simulation

Total P: 30

REFERENCE:  
**One Credit Courses**

**18AK01 Model Based Development**

Introduction- Automotive system modeling using simulink – Control system modeling using Stateflow - verification and validation of models-Functional and implementation models –AUTOSAR-Autocode generation.

Total L: 15

References:

**18AK02 Robotics**

Introduction-components- types and classification of robots - representation of joints and links using D-H parameters- direct and inverse kinematics of manipulators - examples of kinematics of some common manipulator configurations- Purpose and types of sensors, displacement sensors, velocity sensors, force sensors and vision, necessity of actuators, different kinds of actuators – stepper motors, DC servo and brushless motors, programming of robots.

Total L: 15

References:

**18AK03 Integrated Development Environment (IDE)**


Total L: 15

Reference : Manual prepared by Automobile Engineering Department.

**18AK04 Driveline Matching for Special purpose vehicles**

**Off-Road Vehicle**: Performance requirements- selection of engine and tyres- driveline matching and the parameters affecting the same.

Total L: 15

Reference : Manual prepared by Automobile Engineering Department.

**AUDIT COURSES**

**18PP81 ENGLISH FOR RESEARCH PAPER WRITING**

Planning and preparation, word order, breaking up of long sentences, structuring paragraphs and sentences, being concise and removing redundancy, avoiding ambiguity and vagueness, clarifying who did what, highlighting the findings, hedging and criticizing, paraphrasing and plagiarism.

Sections of a paper - Abstract, introduction, review of the literature, methods, results and discussions, conclusions, acknowledgements, references and the final check.

Key skills needed to write title, abstract, introduction, review of the literature, methods, results and discussions, and conclusions of a research paper.
Use of appropriate phrases to ensure the research paper is as good as it could possibly be the first-time submission.  

**REFERENCES:**

**18PP82 RESEARCH METHODOLOGY AND IPR**

Meaning of research problem, sources of research problem, criteria and characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem, approaches of investigation of solutions for research problem, data collection, analysis and interpretation.

Effective literature studies approaches, analysis of plagiarism, research ethics, effective technical writing, how to write report, developing a research proposal, format of research proposal, presentation of research proposal for assessment by a review committee.

Nature of intellectual property: Patents, designs, trade and copyright. Process of patenting and development: Technological research, innovation, patenting, development, international cooperation on intellectual property, procedure for grants of patents, patenting under PCT.

Patent rights: scope of patent rights, licensing and transfer of technology, patent information and databases, geographical indications. New developments in IPR: Administration of patent system, IPR of biological systems and computer software, traditional knowledge case studies on IPR.

**REFERENCES:**