I SEMESTER

18AE01COMPUTATIONAL MATHEMATICS

2 2 0 3

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, Bezier curves and B-spline curves, least squares approximations. (8+7)

NUMERICAL SOLUTION TO ODE: Initial value problem: Runge Kutta method, Milne's method. Boundary value problem: Finite Element Method - Rayleigh-Ritz method, Collocation and Galerkin methods. (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)

Total L: 32 + T: 28= 60

REFERENCES:

1. John H Mathews and Kurtis D Fink, Numerical Methods using MATLAB, Pearson Education, New Delhi, 2018.
2. Steven C Chapra and Raymond P Canale, Numerical Methods for Engineers, Tata McGraw-Hill, New Delhi, 2017.
3. Frank R Giordano, William P Fox and Steven B Horton, A first course in Mathematical Modeling, Cengage Learning, New Delhi, 2014.
4. Curtis F Gerald and Patrick O Wheatly, Applied Numerical Analysis, Pearson Education, New Delhi, 2013.
5. Douglas J Faires and Richard Burden, Numerical Methods, Cengage Learning, New Delhi, 2013.

18AE02 AUTOMOTIVE SYSTEMS

3 2 0 4

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- floating 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)

Total L: 45 + T: 30 = 75

REFERENCES:

1. Heister,Heinz., "Vehicle and Engine Technology", SAE International, 1999.
2. Bosch,Robert., "Automotive Electrics Automotive Electronics", Professional Engineering Publication, 2004.
3. Bosch,Robert., "Automotive Hand book", 2004.
4. Garret,T.Kenneth.,Newton,Kenneth. and Steeds,William.," The Motor Vehicle", Butterworth-Heinemann Limited, 2001.

18AE03 IC ENGINES AND EMISSIONS

3 0 0 3

ENGINE BASIC THEORY AND COMBUSTION: Engine types – otto, diesel, dual operating cycles – Fuel air cycle and actual cycles – Engine design and operating parameters - Two and four stroke engines - Typical performance curves for automobile engines - performance and pollution aspects. Combustion and combustion chambers- Introduction to combustion in SI and CI engines. Stages of combustion. Combustion chemistry and emission formation. Ignition and injection timing Knock, detonation and control. Combustion chambers for SI and CI engines. Direct and indirect injection combustionchambers.Importance of swirl, squish and turbulence. Factors controlling combustion chamber design. (11)

FUEL SYSTEMS, COOLINGAND LUBRICATING SYSTEM: Introduction and fuel system circuit.Air fuel ratio requirements. Working of a carburetor and MPFI. Gasoline direct injection systems. Diesel fuel injection systems-Jerk pumps, distributor pumps, types of nozzles, Unit injector and CRDI systems. Engine governor. Need for cooling, types of cooling systems- air and liquid cooling systems. Water cooling circuit, radiator, water pump and cooling fan. Properties of coolants and additives. Requirements of lubrication systems. Types-mist, pressure feed, dry and wet sump systems. Properties and chemistry of lubricants. (11)

EMISSIONS FROM SI AND CI AND ITS CONTROL: Emission formation in S.I. engines - Hydrocarbons, Carbon monoxide, Oxides of Nitrogen, Polyneculear Aromatic Hydrocarbon. Effects of design and operating variables on emission formation in Spark Ignition engines Controlling of pollutant formation in engines Exhaust after treatment, Charcoal Canister Control for Evaporative Emission Control, emissions and drivability, Positive crank case ventilation system for UBHC emission reduction.Chemical delay, intermediate compound formation, Pollutant formation on incomplete combustion, Effect of design and operating variables on pollutant formation, Controlling of emissions, emissions and drivability, Exhaust gas recirculation, exhaust after treatment. Emission effects on health and environment. (12)

NEW ENGINE TECHNOLOGY: Lean Burn engine – Different approaches to lean bum – LHR engine – Surface ignition concept – catalytic ignition – homogenous charge compression ignition – variable valve timing – turbo and super charging -Multi Port Injection System - Gasoline Direct Injection – Common Rail Direct Injection – Recent Trends. (11)

Total L: 45

REFERENCES:

1. Ganesan, V., “Internal Combustion Engines”, Tata McGraw Hill Book Co, Eighth Reprint, 2005.
2. Crouse, W.H. and Anglin, A.L., “Automotive Emission Control’, McGraw Hill Book Co, 1995.
3. Mathur, M. L., Sharma, R. P., "Internal Combustion Engines", Dhanpat Rai Publication, 2005.
4. Crouse, William., Anglin, Donald., "AUTOMOTIVE MECHANICS", Tata McGraw Hill Book Co, 2006.

18AE04AUTOMOTIVE ELECTRONICS

3 0 0 3

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 Ignitionsystems, electronic fuel control), chassis subsystem (ABS, TCS, & ESP) – Comfort and safety subsystems (night vision, airbags, seatbelt tensioners, cruise control, Lane-departureWarning, parking). (12)

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. (11)

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. (11)

COMMUNICATION PROTOCOLS: Introduction to control networking – Communication protocols in embedded systems – SPI, I2C, USB. Vehicle communication protocols – Introduction to CAN, LIN, FLEXRAY, MOST, KWP2000. (11)

Total L: 45

REFERENCES:

1. Bosch, Robert., “Bosch Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive” Springer Vieweg, Plochingen, Germany, 2014.
2. Ribbens, William. B., “Understanding Automotive Electronics- An EngineeringPerspective”, the Boulevard, Langford Lane, Kidlington, Oxford, 2014.
3. Holembeak, Barry., “Automotive Electricity and Electronics”, Delmar Publishers, Clifton Park, USA, 2010.
4. Halderman, James. D., “Automotive Electricity and Electronics”, Prentice Hall, USA, 2013.

18AE05 VEHICLE DEVELOPMENT PROCESS

3 0 0 3

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)

Total L: 45

REFERENCES:

1. Weber, Julian., “Automotive Development Processes", Springer, 2009.
2. Sörensen,Daniel., "The Automotive Development Process", Springer, 2006.
3. Stark,John., “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007.
4. Lewin,Tony. andBorroff,Ryan., “How to Design Cars Like a Pro”, Motor Books International, 2010.

18AE51AUTOMOTIVE 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

1. Manual prepared by the Department of Automobile Engineering, 2015.

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)

RIDE 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 of braking on vehicle handling. (7+8)

Total L: 30 + T: 30 = 60

REFERENCES:

1. Gillespie, Thomas. D., "Fundamentals of Vehicle Dynamics", SAE USA 2010.
2. Rao,Singiresu. S., "Mechanical Vibrations", Pearson Education Publication, 2009.
3. Giri, N. K., "Automobile Mechanics", Khanna Publishers, New Delhi, 2006.
4. Wong, J. Y., "Theory of Ground Vehicles", John Wiley & Sons, New York, 2012.

18AE07ENGINE COMPONENT DESIGN

3 20 4

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 CRANK SHAFT: Introduction- Design of Journals and Crankpins- Design of Crankwebs- Design of In-Line Engine crankshaft - Design of V type Engine crankshaft. (11+8)

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)

Total L: 45 + T: 30 = 75

REFERENCES:

1. Kolchin, A.I., Demidov, V., "Design of Automotive Engines", MIR Publishers press, 1988.
2. Hoag, Kevin. L.,"Vehicular Engine Design", Springer, 2012.
3. Shigley, Joseph., Mischke, Charles. and Brown, Thomas. H., "Standard Handbook of machine Design",McGraw-Hill Professional, 2004.
4. Heywood, John., "Internal Combustion Engine Fundamentals", McGraw Hill, 2017.

18AE08AUTOMOTIVE EMBEDDED SYSTEM

3 0 0 3

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)

ADVANCED APPLICATIONS: Body electronics – Infotainment systems – Navigation systems – System level tests – Software calibration using engine and vehicle dynamometers – Environmental tests for electronic control unit - Application of Control elements and control methodology in automotive System. (11)

Total L: 45

REFERENCES:

1. Denton, Tom.," Automobile Electrical and Electronic Systems", Elsevier Jordan Hill, Oxford, 2010.
2. Bosch, Robert.," BOSCH Automotive Handbook", Bentley Publications, Massachusetts Avenue, London, 2010.
3. Knowles, Don., "Automotive Electronic and Computer Controlled Ignition Systems", Prentice Hall Publications, New Jersey, 2009.
4. Jurgen, Ronald. K., "Automotive Electronics Handbook", McGraw Hill Publications, Columbus, 2009.
5. Navit,Nicholas., "Automotive Embedded System Handbook", CRC Press Publications, New Delhi, 2008.

18AE09 LINEAR CONTROL SYSTEMS

22 0 3

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.

(8+7)

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. (7+8)

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. (8+7)

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.

(7+8)

Total L: 30 + T: 30 = 60

REFERENCES:

1. Nagrath, I. J. and Gopal, M., “Control Systems Engineering”, New Age International Publishers, 2014.
2. Ogatta, K., “Modern Control Engineering”, Pearson/ Prentice Hall of India Pvt. Ltd., New Delhi, 2013.
3. Nise,Norman. S., “Control Systems Engineering”, John Wiley and Sons Inc., 2012.
4. Umez-Eronini,Eronini., “System Dynamics & Control”, PWS Publishing Company, 1999.
5. Astrom,Karl. J., “Advance PID Controller Control”, Instrumentation Society of America, 1995.

18AE52 AUTOMOTIVE COMPUTER AIDED ENGINEERING LABORATORY

0 042

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

Total P: 60

REFERENCE:

1. Manual prepared by Departmentof Automobile Engineering, 2015.

18AE61INDUSTRIAL VISIT AND TECHNICAL SEMINAR

0 0 4 2

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

0 0 6 3

- 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

0 0 28 14

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

3 0 0 3

BATTERIES: Batteries Types and Battery Packs-Basic Battery Operation-Basic Electrochemistry-Lifetime and Sizing Considerations-Battery Pack Discharge Curves and Aging-Battery Management System-Battery Models-Simple Novel Curve Fit Model for BEV Batteries-Voltage, Current, Resistance, and Efficiency of Battery Pack-Determining the Cell/Pack Voltage for a Given Output\Input Power-The Fuel Economy of a BEV Vehicle with a Fixed Gear Ratio. (13)

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 (12)

BATTERY CHARGING STRATEGIES FOR ELECTRIC VEHICLES: Introduction-Charging algorithms for a single battery-Balancing methods for battery pack charging-Charging infrastructure. (11)

BATTERY MANAGEMENT SYSTEMS: Topology of BMS-BMS representation - Data management and network- SoC and SoH - Battery balancing- Safety aspects of BMSs-BMS standard. (9)

Total L: 45

REFERENCES:

1. Hayes, John. G., "Electric Powertrain- energy Systems, Power electronics and drives". First Edition, John Wiley, New Jersy, United States,2017.
2. Chau, K.T. (edited), "Energy Systems for Electric and Hybrid Vehicles", The Institution of Engineering and Technology, United Kingdom, Published 2016.
3. Wang, Miao., "Mobile Electric Vehicles: Online Charging and Discharging (Wireless Networks)", Springer, Berlin, 2015.
4. Scrosati, B., Garche, J. and Tillmetz, W.,"Advances in Battery Technologies for Electric Vehicles",Woodhead Publishing Series in Energy-Elsevier 2015.

18AE11AUTOMATICAND AUTOMATED MANUAL TRANSMISSION

3 0 0 3

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. (12)

HYDRO-MECHANICAL DRIVES: Major components, principle of planetary gear trains, actuating mechanism, controls system – Types - Manual, governor, throttle and hydraulic control systems. Principle of automatic gear shifting, Typical automatic transmissions. (11)

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. (11)

AUTOMATED MANUAL TRANSMISSION (AMT): Introduction- advantages – Transmission control unit (TCU) - Single-stage 6-speed AMT with range-change unit- Applications -Semi-Automated Manual Transmissions- System structure of an automated manual transmission-Examples of Commercial Vehicle AMT's. (11)

Total L: 45

REFERENCES:

1. Erjavec,Jack., "Automatic Transmissions", Delmar Publishers, 2005.
2. Tucker, H.F., "Automatic Transmission", Van Nostrand Reinhold Company, 1980.
3. Naunheimer,Harald., Bertsche,dnreB. andRyborz, Joachim., "Automotive Transmissions- Fundamentals, Selection, Design and applications", Springer Publishers ,2010.
4. John, J.P. and Tyler, G.H., "Industrial Hydraulics", MGH Published, 1980.

18AE12 AUTOMOTIVE INFOTRONICS

3 0 0 3

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, Radar monitoring system, Ultrasonic sensor, child lock, anti lock braking systems, EBD, ESP, traction control system and lane departure warning system. (11)

COMFORT & SECURITY SYSTEMS: Adaptive cruise control system, active suspension system, power steering, collapsible and tiltable 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. (12)

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. (11)

Total L: 45

REFERENCES:

1. Vlacic,Ljubo., Parent,Michel. and Harashima,Fumio., "Intelligent Vehicle Technologies", Butterworth-Heinemann publications, Oxford, 2001.
2. Bosch,Robert., "Automotive Hand Book", SAE, 2000.
3. Jurgen,Ronald. K., "Navigation and Intelligent Transportation Systems – Progress in Technology", Automotive Electronics Series, SAE, USA, 1998.
4. Broy, Manfred., Krüger,Ingolf. andMeisinger,Michael.,"Automotive software", Springer ,2014

18AE13AUTOMOTIVE ERGONOMICS AND SAFETY

3 0 0 3

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)

Total L: 45

REFERENCES:

1. Bridger, R. S., "Introduction to Ergonomics", Taylor and Francis, London, 2003.
2. Phillips,Chandler. Allen., "Human Factors Engineering", John Wiley & Sons, New York, 2000.
3. Helandar,Martin., "A Guide to Ergonomics of Manufacturing", Taylor and Francis, 1996.
4. Mark, S. S., "Human Factors in Engineering and Design", McGraw Hill, New York, 1993.
5. Fenton,John., "Hand Book of Automotive Power Train and Chassis Design", SAE, 1998.

18AE14AUTONOMOUS VEHICLES

3 0 0 3

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)

NONLINEAR CAMERA: Artificial intelligence and expert systems- GNSS-Aided INS for Fixed-Wing UAV, Machine Vision, Optical Flow, From Optical Flow to Body Velocity, Kalman Filter-Observed System and Filter Equations, Stability of the EKF. (10)

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)

Total L: 45

REFERENCES:

1. Jurgen,Ronald. K. (edited), " Autonomous Vehicle for Safer Driving", SAE International, Warrendale Pennsylvania, USA,2013.
2. Fossen,Thor. I., Pettersen,Kristin. Y. and Nijmeijer, Henk., "Sensing and Control for Autonomous Vehicles-Applications to Land, Water and Air Vehicles" Springer International Publishing AG 2017.
3. Fridman, Alex., Jenik,Benedikt., Reimer, Bryan., "Arguing Machines: Perception- Control system Redundancy and edge case discovery in real- world autonomous driving",ArXiv,2017.
4. Maurer, Markus., Gerdes,naitsirhC .J. andzneL , Barbara., "Autonomous Driving- Technical, Legal and social aspects", Springer Daimler und Benz- Stiftung, Ladenburg 2015.

18AE15 AUTOMOTIVE SAFETY SYSTEM

3 0 0 3

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,

anti lock braking systems, EBD, ESP, traction control system and lane departure warning system. (11)

COMFORT & SECURITY SYSTEMS: Adaptive cruise control system, active suspension system, power steering, collapsible and tiltable 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. (12)

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. (11)

Total L: 45

REFERENCES:

1. Vlacic,Ljubo., Parent,Michel. and Harashima,Fumio., "Intelligent Vehicle Technologies", Butterworth-Heinemann publications, Oxford, 2001.
2. Bosch,Robert., "Automotive Hand Book", SAE, 2000.
3. Jurgen,Ronald. K., "Navigation and Intelligent Transportation Systems – Progress in Technology", Automotive Electronics Series, SAE, USA, 1998.
4. William, B. R., "Understanding Automotive Electronics", Butter worth Heinemann Woburn, 1998.

18AE16ELECTRONIC ENGINE MANAGEMENT

3 0 0 3

INTRODUCTION: Purpose of electronic engine management system - Business & Engineering Need: Meet market specific need and legislative norms (Emission & Safety).Improve the engine performance (Torque and Speed characteristics), fuel economy and driving comfort. Software Architecture - Overview for Engine Management System, Overview of Safety standards (ISO26262 ASIL), AUTOSAR overview, Diagnostic and Monitoring System overview. (12)

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. (11)

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). (11)

DIESEL ENGINE: CRDI System – Fuel Injection control for engine performance optimization (Speed, Torque, Vibration and Noise),NOx control via Injection control,EGRcontrol,NOx storage catalyst, Selective Catalyst Reduction. Particulate control via particulate trap and regeneration. (11)

Total L: 45

REFERENCES:

1. Ronald, K. J., "Automotive Electronics Handbook", McGraw Hill Book Co, 1999.
2. William, B. R., "Understanding Automotive Electronics", SAE Publications 2004.
3. Bosch,Robert., "Diesel Engine management" Bentley Publishers, Cambridge, 2004.
4. Bosch,Robert., "Gasoline Engine management" Bentley Publishers, Cambridge, 2004.

18AE17 SENSORS AND ACTUATORS

3 0 0 3

AUTOMOTIVE SENSORS: Introduction to sensors and variables to be measured in an automotive measurement and control applications. Airflow Rate Sensor, Pressure Measurement –Strain gauge MAP sensor. Engine Crank Position sensor-Magnetic reluctance, Hall effect and optical crank position sensor, Throttle angle sensor, Temperature Sensor. Sensors for Engine feedback control – EGO sensor, EGO characteristics, Magneto strictive principle and Knock sensor. (11)

AUTOMOTIVE ACTUATORS: Introduction to actuators and variables to be controlled, Engine control actuators, Pulse width Modulated signal and H-bridge device for speed and direction control. Electric motor actuator –DC motor, Brushless DC Motor, Stepper Motor and Servomechanism. Engine control actuators-Fuel injector (solenoid, Piezo electric type), Ignition coil operation, EGR Actuator, Electric actuators- Relays, Reed switch. (12)

OPERATIONAL AMPLIFIER:OP-Amp: Introduction, Basics, Ideal OP-AMP, Open Loop and feedback in OP-AMP operation, Inverting and non-inverting amplifier, Voltage follower and Differential amplifiers. Difference mode, Common mode gain, CMRR, Operation amplifier internal circuit, Example of OP-AMP IC's (IC 741), OP-Amp D.C characteristics. - Operational Amplifier Applications. (11)

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)

Total L: 45

REFERENCES:

1. Ribbens,William. B., "Understanding Automotive Electronics", 7th Edition Butterworth-Heinemann publications, 2012.
2. Choudhry,D. Roy. andJain,Shail., "Linear Integrated Circuits", New Age International Pvt. Ltd., 2000.
3. Jurgan,Ronald. K., "Automotive Electronics Handbook", 2nd Edition , McGraw-Hill, Inc., 1999.
4. Franco,Sergio., "Design with Operational Amplifiers and Analog Integrated Circuits", 3rd Edition, Tata Mc Graw-Hill, 2007.

18AE18VEHICLE DIAGNOSTICS

3 0 0 3

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)

Total L: 45

REFERENCES:

1. Denton,Tom., "Advanced Automotive Fault Diagnosis", Routledge, 2011.
2. Denton,Tom., "Automotive Electronics Handbook", McGraw-Hill Publishing Co.; 2nd revised edition 1999.
3. Denton, Tom., "Automobile Electrical and Electronic Systems", Routledge,4th edition, 2012.
4. Jurgan,Ronald. K. "Automotive Electronics Handbook", 2nd Edition , McGraw-Hill, Inc. 2008

18AE19 AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS

3 0 0 3

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)

Total L: 45

REFERENCES:

1. Bell,Joseph., "Diesel Engineering: Electricity and Electronics", Cengage Learning, New Delhi, 2007.
2. Bosch,Robert., "Automotive Hand Book" SAE, 2000.

3. Bosch,Robert.,"Automotive Electrics Automotive Electronics", GmbH, 2004.
4. Denton, Tom., "Automobile Electrical and Electronics systems", Routledge Taylor & Francis Group London & New York, 2002.

DESIGN ENGINEERING STREAM ELECTIVES

18AE20 FINITE ELMENT ANALYSIS

3 0 0 3

INTRODUCTION: Historical background, Concept of finite element method, boundary, initial and eigen value problems, Finite element formulation starting from governing differential equations – Weighted residual method, Finite element formulation based on stationary of a functional. Review of static analysis using 1D elements. (10)

STATIC ANALYSIS AND DYNAMIC ANALYSIS: Triangular and quadrilateral elements, Isoparametric formulation, problems using 2D elements, shape functions for axisymmetric and 3D elements, shape functions for higher order elements. Introduction to plates and shells. Equations of motion for dynamic problems. Consistent and lumped mass matrices. Formulation of element mass matrices. Free vibration problem formulation, Solution of Eigen value problems using 1D elements, Time dependent one-dimensional bar analysis. (12)

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. (11)

NON-LINEAR ANALYSIS: Introduction, Non-linear differential equation, Solution procedures for non-linear problems, Linearization and directional derivative, Material non-linearity-analysis of axially loaded bars, Geometric non-linearity-Basic continuum mechanics concepts, Governing differential equations and weak forms, Introduction to contact problems. (12)

Total L: 45

REFERENCES:

1. Chandrupatla, T. R. and Belegundu, A. D., "Introduction to Finite Elements in Engineering", Pearson Education, New Delhi, 2007.
2. Logan, D. L., "A First Course in the Finite Element Method", Thomson Learning, 2007.
3. Rao, S. S., "The Finite Element Method in Engineering", Elsevier, 2005.
4. Cook, R. D., Malkus, D. S. and Plesha, M. E., "Concepts and Applications of Finite Element Analysis", John Wiley and Sons, New Delhi, 2003.

18AE21AERODYNAMICS OF ROAD VEHICLES

3 0 0 3

AERODYNAMIC DRAG OF CARS: Introduction: Fundamentals of fluid mechanics, flow phenomenon related to vehicles, external and internal flows. Cars as a bluff body, flow field around car, air flow to passenger compartment, drag force, types of drag force, analysis of aerodynamic drag, drag coefficient of cars, strategies for aerodynamic development, low drag profiles. (12)

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. (11)

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. (12)

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. (10)

Total L: 45

REFERENCES:

1. Hucho, W. H., "Aerodynamic of Road vehicles ", Butterworth Co. Ltd., 1997.
2. Pope, A., "Wind Tunnel Testing ", John Wiley & Sons, New York, 1974.
3. "Automotive Aerodynamic: Update SP-706", SAE, 1987.
4. "Vehicle Aerodynamic", SP-1145, SAE, 1996.
5. McCallen, R., Browand, F. and Ross, J., "The Aerodynamics of Heavy Vehicles: Trucks, Buses, and Trains", Springer, 2004.

18AE22COMPUTATIONAL FLUID DYNAMICS

3 0 0 3

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. (10)

DISCRETISATION: Finite difference method - forward, backward and central difference schemes, Explicit and implicit methods: Numerical solution for heat transfer and fluid flow problems for steady state and transient conditions, Stability analysis and error estimation. Grid generation: Choice of grid, grid oriented velocity components, cartesian velocity components, staggered and collocated arrangements. (12)

CFD TECHNIQUES: Lax - Wendroff technique - MacCormack's technique, Relaxation technique. ADI technique, Pressure correction technique, SIMPLE algorithm. Fluid flow and convection problems: Upwind scheme, Stability criteria. (11)

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. (12)

Total L: 45

REFERENECES:

1. Muralidhar, K. and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publications, New Delhi, 2003.
2. Chung, T. J., "Computational Fluid Dynamics", Cambridge University Press, London, 2002.
3. David, C. Wilcox., "Turbulence Modeling for CFD", DCW Industries, Inc., 1993.
4. Versteeg, H. K. and Malalasekara, W., "An Introduction to Computational Fluid Dynamics - The Finite Volume Method', Longman, 1995.

18AE23AUTOMOTIVE SYSTEM DESIGN AND SIMULATION

3 0 0 3

Principles of mathematical modeling of mechanical systems: Introduction-Mathematical Modeling- Bars Under Axial Vibration- Bars Under Torsional Vibration Beams Under Flexural Vibration- Systems Governed by Second-Order PDEs- Properties of the Laplace Transform- Time Response via the Laplace Transform- The Inverse Laplace Transform- The Final- and the Initial-Value Theorems. (12)

Vibration Analysis of Two-DoF Systems: Constitutive Equations of Mechanical Elements- springs and dashpots – series and parallel arrays –Hysteric Damping- Coulomb damping-Introduction-The Derivation of the Governing Equations-Equilibrium States-Linearization of the Governing Equations- Lagrange Equations of Linear Mechanical Systems. Introduction-Natural Frequencies and the Natural Modes-The Zero-Input Response of Two-DoF Systems-Damped Two- DoF Systems. (11)

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. (11)

Suspension and tire modeling: Quarter car model - Kinematics of a Double Wishbone Suspension - Modeling Aspects - Constraint Equations - Spring Damper in Series tire modeling- – Pacejaka magic formula- brush and Dugoff model- Introduction to full car model with 16 DoF. (11)

Total L: 45

REFERENCES :

1. Angeles,Jorgge.," Dynamic response of linear Mechanical systems -Modeling,Analysis and Simulation", Elsevier press, 2008.
2. Rill, Georg.," Road vehicle dynamics- Fundamentals and modeling", CRC press,2009.
3. Nazar, Reza. N., "Vehicledynamics: Thoery and application",Springer, 2008.
4. Maurer, Markus. and Winner, Hermann.,"Automotive Systems Engineering", Springer, 2013,

18AE24DESIGN FOR MANUFACTURE AND ASSEMBLY

3 0 0 3

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. (12)

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)

Total L: 45

REFERENCES:

1. Bralla,James. G. , "Design for Manufacturability Handbook", McGraw Hill Professional, 1999
2. Boothroyd, G., Dewhurst, P. and Knight, W., "Product Design for Manufacture and Assembly", Marcell Dekker, 1994.
3. Graedel,T. E. and Allenby,Braden. R. , "Design for environment", Prentice Hall, 2007
4. Poli, Corrodo., "Design for Manufacturing – A structured Assembly", Elsevier, 2009.

18AE25AUTOMOTIVE POWERTRAIN DESIGN

3 0 0 3

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)

FLYWHEEL AND CLUTCH: Requirements of flywheel. Design procedure for flywheel. Design of single and multi-plate clutches. (11)

Total L: 45

REFERENCES:

1. Kolchin, A. and Demidov, V., "Design of Automotive Engines", MIR Publishers 1998.
2. Hoag, Kevin.and Dondlinger, Brian.," Vehicular Engine Design",Springer, 2015.
3. Fenton,John., "Gasoline Engine analysis for CAD", MEP, London, 1986.
4. Crolla, David. anfMasadi, Bahrooz.," Vehicle Power train Systems", John Wiley and Sons -2011.

Automotive Manufacturing Stream Electives

18AE26ADVANCED MANUFACTURING PROCESSES

3 0 0 3

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)

NON-TRADITIONAL MACHINING: Introduction, need, AJM, Parametric Analysis, Process capabilities, USM –Mechanics of cutting, models, Parametric Analysis, WJM –principle, equipment ,process characteristics , performance, EDM – principles, equipment, generators, analysis of R-C circuits, MRR , Surface finish, WEDM. (11)

LASER BEAM MACHINING: Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications. Plasma Arc Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications. Electron Beam Machining - Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications. Electro Chemical Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications. (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 micro electronics, surface mount technology, Integrated circuit economics. Manufacturing, nanotechnology, and micromachining, High speed Machining. (12)

Total L: 45

REFERENCES:

1. Kalpakijian., "Manufacturing Engineering and Technology" ,Adisson Wesley, 1995.
2. Lindburg, R. A.,"Process and Materials of Manufacturing" , 4th edition, PHI 1990.
3. Liu, Chang.," Foundation of MEMS" ,Pearson, 2012.
4. Jain, V.K.," Advanced Machining Processes", Allied Publications,2012.

18AE27LEAN MANUFACTURING

3 0 0 3

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. (9)

LEAN METHODS: Value Stream Mapping: - Detailed process map - Use of VSM software. Group Technology - Machine cell design - Facility layout optimization - Quality at source - 5S principles – One piece flow - Pull vs Push - JIT - Kanban. Information technology aids – Smart manufacturing. Case Studies from various industries. (10)

LEAN TOOLS: Standard work - SOP. Spaghetti diagram – Process Map. Visual controls - Marquee - Andon - Vision system - Score board. Total Integrated Automation - TPM - OEE - TQM - SMED - FMEA - Line balancing - Poka-yoke/ Error mistake proofing - Information technology aids. Case Studies from various industries. (20)

LEAN IMPLEMENTATION: Road map 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. (6)

Total L: 45

REFERENCES:

1. Liker,Jeffrey. and Convis,Gary. L., "The Toyota Way to Lean Leadership: Achieving and Sustaining Excellence through Leadership Development", McGraw Hills, 2012.
2. Askin, R. G. and Goldberg, J. B., "Design and Analysis of Lean Production Systems", John Wiley and Sons Inc., 2003.
3. George,Michael. L., Rowlands,David. T. andKastle,Bill., "What is Lean Six Sigma", McGraw Hill, New York, 2004.
4. Robinson,Alan., "Continuous Improvement in Operations", Productivity Press, Portland, Oregon, 1991.

.

18AE28LEAN SIX SIGMA

3 0 0 3

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. (14)

DMAIC PROJECT: DEFINE: Problem statement - VOC – CTQ – Affinity process – Pareto diagrams – BRD – Project charter – High level process map – Project team – SIPOC. MEASURE: Types of measures – Types of data. Collect data from "As is" model. Carry out Cause and effect diagrams – Line, bar, stacked bar graphs – Pie chart – Histograms. Six sigma measurements: COPQ – QLF - Process capability study. ANALYSE: Process capability analysis – Correlation analysis - DOE/ANOVA, Chi square test. IMPROVE: Process redesign, generating alternatives for improvement. Conduct pilot experiments - Cost/benefit analysis – Implementation plan – Risk analysis and mitigation. (22)

DESIGN FOR SIX SIGMA (DFSS) PROJECT: DFSS methodologies - QFD - Theory of Inventive Problem Solving (TRIZ) - FMEA - Design for XDFX – Robust design and process. (6)

LEAN SIXSIGMA IMPLEMENTATION: Roadmap to implement or execute a lean six sigma project. Software tools available for DMAIC and/or DFSS. (3)

Total L: 45

REFERENCES:

1. Feo,Joseph. De. andBarnard,William., "Juran Institute's Six Sigma Breakthrough and Beyond", The McGraw-Hill Companies, 2004.
2. Ehrlich,Betsiharris., "Transactional Six Sigma and Lean Servicing", St. Lucia Press, 2002.

3. Arthur, Jay., “Lean Six Sigma – Demystified”, Tata McGraw Hill Companies Inc, 2007.
4. George,Michael. L., Rowlands,David. T. and Kastle,Bill., “What is Lean Six Sigma”, McGraw Hill, New York, 2004.

18AE29AUTOMOTIVE MATERIALS AND METALLURGY

3 0 0 3

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. (11)

NON METALLIC MATERIALS AND THEIR PROCESSING: Polymers, elastomers – types, properties and applications. laminated&heat treated glass, adhesive bonding. Electrical insulating materials. Gaskets, automotive glasses, Sound insulating materials, Protective coating materials - Paints, primers, varnishes, enamels. Processing of polymers and elastomers. Automotive applications of non metallic materials. (11)

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., (12)

MATERIALS FAILURES AND DESIGN: Materials behaviour under mechanical loading - Plastic deformation - Strengthening mechanisms - Griffith's theory of failure modes –- Damping properties of materials - fracture toughness - Initiation and propagation of fatigue cracks - Creep mechanisms environmentally induced degradation and preventive solutions. Automotive component failure analysis and case studies, types of failures, fracture mechanisms, types of defects in metals & cracks, types of fatigue, importance of endurance life. (11)

Total L: 45

REFERENCES:

1. Yamagata,H.,” The Science and Technology of Materials in Automotive Engines”, Woodhead Publishing Ltd, Cambridge, United Kingdom, 2005.
2. “Pistons and engine testing”, second edition, MAHLE, 2011.
3. Courtney,Thomas.H.,“Mechanical Behavior of Materials”, McGraw Hill,2000.
4. Budinski,Kenneth. G. and Budinski,Michael. K. “Engineering Materials” Prentice-Hall of India Private Limited, 4th Indian Reprint 2002.

Thermal Engineering Stream Electives

18AE30EMISSION, NOISE, VIBRATION AND HARSHNESS CONTROL

3 0 0 3

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. (10)

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. (12)

Noise analysis and control methods: Transfer Path Analysis: single source structure-borne noise transmission path analysis, multiple reference transmission path analysis, Impedance modelling, modal analysis: definition of modal properties, modal analysis theory, passive noise control methods: ducts & mufflers -types of mufflers, performance parameters – acoustics and backpressure, reactive and absorptive silencers, helmholtz resonators and side branch resonators. (10)

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. (13)

Total L: 45

REFERENCE:

1. Harrison,Matthew., “Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles”, SAE International, 2004.
2. Munjal, M.L., “Acoustic Ducts and Mufflers”, John Wiley, 1987
3. Rajamani,Rajesh., “Vehicle Dynamics and Control”, 2nd edition, Springer, 2011.
4. Wang,Xu., “Vehicle noise and vibration refinement”, Wood head publishing Limited, 2010.

18AE31ADVANCED HEAT TRANSFER

3 0 0 3

INTRODUCTION TO MODES AND LAWS OF HEAT TRANSFER: Simultaneous Heat Transfer Mechanism, Steady and Transient Heat Transfer, Multidimensional Heat Transfer, Thermal Conductivity, Thermal diffusivity, Various Boundary and Initial Conditions, General Heat Conduction Equation, Thermal Resistance, Generalized Thermal Resistance Networks, Thermal Contact Resistance. (11)

TRANSIENT HEAT CONDUCTION AND FLUID FLOW AND CONVECTIVE HEAT TRANSFER: Lumped capacitance and its validity, General lumped capacitance analysis, spatial effects. Problems related with conventional geometries. Concept of velocity and thermal boundary layers: Laminar and Turbulent flow. Navier stokes equations and convection equation. Boundary layer approximations and special conditions. Boundary layer similarity. The normalized convection transfer equations. Dimensionless parameters & physical significance. (12)

CONVECTION: External forced convection: Parallel flow over Flat plates, Flow across cylinders, Flow across tube banks. Internal forced convection: Entrance region, Constant surface heat flux, Constant surface temperature, Laminar and Turbulent flow in tubes. Natural Convection: Physical Mechanism, Equation of motion and Grashof Number, Natural Convection over surfaces. (11)

BOILING AND CONDENSATION: Boiling modes, the boiling curve, modes of pool boiling, correlations. Forced convection boiling. Two phase flow. Condensation: Physical mechanisms, laminar film condensation on a vertical plate. Turbulent film condensation, film condensation on radial systems, film condensation in horizontal tubes, on banks of tubes, Dropwise condensation correlations. (11)

Total L: 45

REFERENCES:

1. Incropera, Dewitt.,"Fundamentals of Heat and Mass Transfer" , John Wiley and sons., 2001.
2. Cengel, Yunus. andGhajar, Afshin.,"Heat and Mass Transfer" , Tata Mc Graw Hill., 2007.
3. Ozisik, M.N.,"Heat transfer - A basic approach", Mc Graw Hill Int., 2011.
4. Bejan, A.,"Convective Heat transfer", John Wiley and sons, 2003.

18AE32 ALTERNATIVE FUELS

3 0 0 3

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. (11)

ENGINE PERFORMANCE AND EMISSION CHARACTERISTICS: Principle of combustion, Engine performance parameters, Operating variables that affect SI and CI engine performance, efficiency and emissions, Emission formation in SI and CI engines - UBHC, NOx, CO, CO2, Particulate emissions, Aldehydes, SOx. Emission effects on health and environment, Emission Norms. (11)

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. (12)

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. (11)

Total L: 45

REFERENCES:

1. Haywood,John. B., "Internal Combustion Engine Fundamentals", McGraw-Hill Book Company, 2001.
2. Bechtold,Richard. L., "Alternate Fuels – Transportation Fuels for Today and Tomorrow", Society of Automotive Engineers (SAE) – 2002.
3. "Alcohols as Motor Fuels", SAE, 2012
4. Watson, E.B., "Alternative fuels for the combustion engine", ASME, 2011.

18AE33 AUTOMOTIVE HVACR

3 0 0 3

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. (11)

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. (12)

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. (11)

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. (11)

Total L: 45

REFERENCES:

1. Birch,Tom., “Automotive Heating and Air Conditioning” Pearson Education Inc., 2003.
2. Dwiggins,Boyce. H., Erjavec,Jack., “Automotive Heating and Air-Conditioning”, Delmer publisher.,2009.
3. Crouse,William. H. and Anglin,Donald. L., “Automotive air conditioning”, McGraw - Hill Inc., 2010.
4. Daly,Steven., “Automotive Air Conditioning and Climate Control System”, Butterworth Heinemann, 2006.

18AE34FUELS AND COMBUSTION

3 0 0 3

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. (11)

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. (12)

COMBUSTION IN SI ENGINES: Initiation of combustion - flame velocities – flame propagation - normal and abnormal combustion - knocking combustion - pre-ignition - knock and engine variables – features and design consideration of combustion chambers - stratified charge combustion - concepts of lean burn engines - heat release correlations. Flow visualization and modeling, concept of combustion quality, ignition and its effect. (11)

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. (11)

Total L: 45

REFERENCES:

1. Ganesan, V., “Internal Combustion Engines”, Tata McGraw Hill Book Cop.,2005
2. John, B. Heywood, “Internal Combustion Engine Fundamentals”, McGraw Hill Book, 2008.
3. Mathur M. L., and Sharma, R. P., “A Course in Internal Combustion Engines”, Dhanpat Rai Publications Pvt. New Delhi, 2007.
4. Obert, E. F.,” Internal Combustion Engine and Air Pollution”, International Text Books Publishers, 2000.

18AE35 SIMULATION OF IC ENGINES

3 0 0 3

INTRODUCTION TO MODELLING: Advantages of computer simulation, Classification of engine models. Intake and exhaust flow models – Quasi steady flow - Filling and emptying - Gas dynamic Models. Thermodynamic based in cylinder models. Step by step approach in SI engine simulation. (11)

COMBUSTION AND STOICHIOMETERY: 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. (11)

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. (12)

COMPUTER SIMULATION OF CI ENGINE: Zero, one and multizone models for diesel engine combustion. Double Wiebe's Law analysis for diesel combustion. Heat release model and different heat transfer models. Equilibrium calculations. Parametric studies on simulated engine performance. (11)

Total L: 45

REFERENCES:

1. Ganesan, V., "Computer Simulation of spark ignition engine process", Universities Press (I) Ltd, Hyderbad, 1996.
2. Heywood, John. B., 'Internal Combustion Engines'", Tata McGraw Hill Co., Newyork, 1988.
3. Ramoss, A.L., "Modelling of Internal Combustion Engines Processes", McGraw Hill Publishing Co.,1992.
4. Campbel, Ashley., "Thermodynamic analysis of combustion engines", John Wiley & Sons, New York, 1986.

18AE36 INSTRUMENTATION FOR THERMAL SYTEMS

3 0 0 3

MEASURMENT CHARACTERISTICS: Instrument Classification, Characteristics of Instruments – Static and dynamic, experimental error analysis, Systematic and random errors, Statistical analysis, Uncertainty, Experimental planning and selection of measuring instruments, Reliability of instruments. (11)

MICROPROCESSORS AND COMPUTERS IN MEASURMENT: Data logging and acquisition – use of sensors for error reduction, elements of micro computer interfacing, intelligent instruments in use. (11)

MEASURMENT OF PHYSICAL QUANTITIES: Measurement of thermo-physical properties, instruments for measuring temperature, pressure and flow, use of sensors for physical variables. (11)

MEASURMENT TECHNIQUES AND ANALYSERS: Shadowgraph, Schlieren, Interferometer, Laser Doppler Anemometer, Hot wire Anemometer, heat flux sensors, Telemetry in measurement. Orsat apparatus, Gas Analysers, Smoke meters, gas chromatography, spectrometry. (12)

Total L: 45

REFERENCES:

1. Holman, J.P., "Experimental methods for engineers", McGraw-Hill, 2012
2. Barnery.," Intelligent Instrumentation", Prentice Hall of India, 2011.
3. Prebrashensky, V., "Measurements and Instrumentation in Heat Engineering, Vol. 1 and 2", MIR Publishers, 2007
4. Raman, C.S., Sharma, G.R. and Mani, V.S.V., "Instrumentation Devices and Systems", Tata McGraw- Hill, New Delhi, 2001.

18AE37 THERMAL MANAGEMENT OF HYBRID SYSTEMS

3 0 0 3

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. (12)

THERMAL MANAGEMENT OF MOTORS: Motor Sizing vs Heat Generation - Operational Temperature Limitations of Electrical Insulation - Design concepts for Heat Extraction in Motors for xEV systems - Modelling and simulation of heat transfer in motors - Rendering of Heat extraction solutions - Sensors and Protection solutions. (11)

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

generation - Lumped cell and pack models for transient temperature response to drive cycles - Model parametric study results (11)

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. (11)

Total L: 45

REFERENCES:

1. Nag, P.K., "Engineering Thermodynamics", 5th Edition, Tata McGraw Hill Education, New Delhi, 2013.
2. Sergent,Jerry. andKrum,Al., "Thermal Management Handbook: For Electronic Assemblies Hardcover", McGraw- Hill. 2005.
3. "Vehicle thermal Management Systems Conference Proceedings, 1st Edition", Coventry Techno Centre, UK, 2013.
4. Shabany, Younes.," Heat Transfer: Thermal Management of Electronics Hardcover", CRC Press. 2010,
5. Obidi,T. Yomi., "Thermal Management in Automotive applications", SAE International, 2015.

18AE38 FUEL CELL VEHICLES

3 0 0 3

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. (10)

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 serious connection, over-potential and polarizations, generous issues -water flooding and water management. (11)

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. (12)

Fuel Cell Vehicle architecture: Hybrid Vehicle configurations – Parallel, Series and Parallel-Series, Fuel cell Vehicle Drives, Recent developments in battery technology for automobile applications, Modeling, Simulation, and Control of Hybrid fuel cell vehicles, Advanced heating and cooling systems for hybrid fuel cell vehicles. (12)

Total L: 45

REFERENCES:

1. Babir, Frano., "PEM FUEL CELLS: Theory and Practice", Elsevier Academic Press, USA, 2005.
2. Viswanathan, B. and Scibioh, Aulice. M., "Fuel cells: Principles and Applications", University Press, 2006.
3. Mench,M. M., "Fuel cells Engines", John Wiley and Sons, 2008.
4. Ehsani, Mehrdad., Gao,Yimin., Gay,Sebastien. E. and Emadi,Ali., "Modem Electric, Hybrid Electric and Fuel cell Vehicles", Fundamental, Theory and design ", CRS Press, 2004.

OTHER ELECTIVES

18AE39SPECIAL VEHICLES

3 0 0 3

TRACTORS AND GRADERS: Tractors - General description, specification and functions, light, medium and heavy wheeled tractors, crawler tracks mounted / wheeled - Bull dozers, tilt 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. (12)

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. (10)

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. (13)

HAULAGE VEHICLES AND LIFT TRUCKS: General description, specification and functions, self-propelled and tractor towed haulage vehicles and pneumatic – tires, dumpers – front tipping; trucks – rear tipping, tractor towed semi-trailers and trailers (rear and side tipping, bottom dumping). General description, specification and functions, fork lift trucks, alternative front-end equipment (attachments) – Jib arm, shovel bucket, squeeze clamp, boom, fork extensions, barrel forks. Scissors lift trucks - Applications in industry, advantages and disadvantages. (10)

Total L: 45

REFERENCES:

1. Peurifoy, R.L., "Construction Planning, Equipment and Methods", Tata McGraw-Hill, New Delhi, 2002.
2. Graham,Ian., "Off-Road vehicles", Heinemann Library, 2008.
3. Wong, J. "Terramechanics and Off-Road Vehicle Engineering", Butterworth-Heinemann, 2009.
4. Roninson,E.G., "Motor Graders", MIR Publications, Moscow, 2005.

18AE40VEHICLE TESTING

3 0 0 3

RIDE, VIBRATION AND BODY TEST: Vibration measurement instrument – accelerometer and signal conditioning, graphical presentation. Dynamic simulation sled testing, methodology, vehicle acceleration measurement and documentation. Dolly roll over test, dolly role over fixture, photographic / video coverage, instrumentation. Vehicle roof strength test – test procedure and test measurements. Door system crush test –procedure and measurements- wind tunnel selection and Reynolds number capability, model requirements, model details, model mounting, test procedure. (11)

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. (11)

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. (11)

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 conditions. Traction loss and roll instability simulation. (12)

Total L: 45

REFERENCES:

1. Crouse, W. H. and Anglin, D. L., "Automotive Mechanics"' Tata McGraw Hill Publishing Company, 2004.
2. Rangan, Mani and Sharma, "Instrumentation", Tata McGraw Hill Publishers, New Delhi, 2004.
3. "SAE Hand book, Vol. 3", SAE Publications, 2009
4. Stockel, M. W., "Auto Mechanics Fundamentals", Good Heart-Wilcox Co., Inc., 2008

18AE41 OPTIMIZATION TECHNIQUES

3 0 0 3

Network Analysis: Maximal flow problems-Shortest Route Problems-Minimal Spanning Tree Problems-Minimum Cost Capacitated Flow problem- PERT and CPM including crashing. (10)

Advanced Topics in Linear Programming: Revised Simplex Method- Integer programming- Traveling salesman problem- Goal programming. (10)

Dynamic Programming: Concepts-Mathematics description- Deterministic Dynamic Programming (Examples: Facilities selection problem, Cutting stock problem, Inventory control problem) Problems-Nonlinear Programming problem- Formulation-Solution Methodology- Problem (Curse) of Dimensionality in Multi State Variables Problem. (12)

Nonlinear Programming (Unconstrained and Equality, inequality Constraints): Basic Concepts-Taylor's Series expansions-Fibonacci and Golden Section search- Hooks and Jeeves search- Gradient Methods with equality constraints.Khun concept- Khun Tucker conditions- Quadratic Programming-Complementary Algorithm- Separable Programming- Concept of non-derivative search techniques: GA, SAA & TS. (13)

Total L: 45

REFERENCES:

1. Taha,Hamdy. A., “Operations Research- An Introduction”, MacMillan Co., Seventh Edition 2003.
2. Ravindran,A., Phillips,Don.T., and Solberg,James. J., “Operations Research- Principles and Practice”, John Wiley and Sons, Second Edition, Copy right 2011.
3. Srinath, L.S., “PERT and CPM Principles and Applications”, Affiliated East West Press Pvt. Ltd., New Delhi, 2005.
4. King, J.R., “Production Planning and Control”, Pergamon Press Oxford, 2009

18AE42AUTOMOTIVE PLM

3 0 0 3

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 approachto 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)

Total L: 45

REFERENCES:

1. Wang,Lihui. and Andrew, Y. C. N., “Collaborative Design and Planning for Digital Manufacturing”, Springer-Verlag London Limited, 2009.
2. Stark,John., “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007.
3. Grieves,Michael., “Product Life Cycle Management”, Tata McGraw Hill, 2006.
4. Stark,John., “Product Lifecycle Management: 21 Century Paradigm for Product Realization”, Springer Publisher, 2005.

18AE43 AUTOMOTIVE ERGONOMICS

3 0 0 3

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)

Total L: 45

REFERENCES:

1. Bridger, R. S., “Introduction to Ergonomics”, Taylor and Francis, London, 2003.
2. Phillips,Chandler. Allen., “Human Factors Engineering”, John Wiley & Sons, New York, 2000.
3. Helandar,Martin., “A Guide to Ergonomics of Manufacturing”, Taylor and Francis, 2006.
4. Mark, S. S., “Human Factors in Engineering and Design”, McGraw Hill, New York, 2001.

ELECTIVE LABORATORY COURSES

18AE53 AUTOMOTIVE STYLING AND DESIGN LABORATORY

0 02 1

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:
1. Manual prepared by the Department of Automobile Engineering, 2015.

15AE54 AUTOMOTIVE EMBEDDED SYSTEMS LABORATORY

0 0 2 1

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:
1. Manual prepared by the Department of Automobile Engineering, 2015.

18AE55MODELING AND SIMULATION LABORATORY

0 0 2 1

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 usingPacejaka'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:
1. PSG Tech Lab Manual.
2. Crolla, David. and Masahadi,Behrooz.,"Vehicle Power train systems",John Wiley and sons Publication -2012 .
3. Rill, Georg.,"Road Vehicle dynamics -Fundamentals and Modeling", CRC Press_2013.

One Credit Courses

18AK01 Model Based Development

1 0 0 1

Introduction- Automotive system modeling using simulink – Control system modeling using Stateflow- verification and validation of models-Functional and implementation models –AUTOSAR-Autocode generation. (15)

Total L: 15

References:

1. Kugele,Stefan. M. ,"Model-based Development of Software-intensive Automotive Systems",Springer , 2012.
2. Navet,Nicolas. andSimonot-Lion,Francoise.,"Automotive Embedded Systems Handbook", CRC press 2014.
3. Zander,Justyna., Schieferdecker,Ina. andMosterman,Pieter. J.,"Model-Based Testing for Embedded Systems", CRC press 2011.

18AK02 Robotics

1 0 0 1

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. (15)

Total L: 15

References:

1. Morecki, Adam. and Knapczyk, Jozef.,"Theory and Components of Manipulators and Robots", Springer ,2011.
2. Dinwiddie, Keith.,"Basic Robotics", Cengage learning ,2009.

18AK03Integrated Development Environment (IDE)

Fundamentals of KEIL – basics programming ant interfacing with hardware . Fundamentals of Code Warrior – basics programming ant interfacing with hardware. (15)

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. (8)

Motor sports Vehicle : Performance requirements- selection of engine and tyres- driveline matching and the parameters affecting the same. (7)

Total L: 15

Reference :

Manual prepared by Automobile Engineering Department.

AUDIT COURSES

18PP81 ENGLISH FOR RESEARCH PAPER WRITING

0 0 4 0

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 criticising, paraphrasing and plagiarism. (15)

Sections of a paper - Abstract, introduction, review of the literature, methods, results and discussions, conclusions, acknowledgements, references and the final check. (10)

Key skills needed to write title, abstract, introduction, review of the literature, methods, results and discussions, and conclusions of a research paper. (20)

Use of appropriate phrases to ensure the research paper is as good as it could possibly be the first- time submission. (15)

Total P: 60

REFERENCES:

1. Adrian Wallwork, “English for Writing Research Papers”, Springer New York Dordrecht Heidelberg London, 2011.
2. Goldbort R., “Writing for Science”, Yale University Press, 2006.
3. Day R., “How to Write and Publish a Scientific Paper”, Cambridge University Press, 2006
4. Highman N., “Handbook of Writing for the Mathematical Sciences”, SIAM, Highman’s Book, 1998.

18PP82 RESEARCH METHODOLOGY AND IPR

0 0 6 0

Meaning of research problem, sources of research problem, criteriaandcharacteristics 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. (25)

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. (20)

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. (20)

Patent rights: scope of patent rights, licensing and transfer oftechnology, 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. (25)

Total P: 90

REFERENCES:

1. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016.
2. Ranjit Kumar, “Research Methodology: A Step by Step Guide for Beginners”, Sage Publication, 2nd Edition, 2010.
3. Ramappa T., “Intellectual Property Rights Under WTO”, S Chand Publication, 2008.
4. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd, 2007.
5. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”, 2001.
6. Stuart Melville and Wayne Goddard, “Research Methodology: An Introduction for Science & Engineering Students”, 1996.
7. Mayall, “Industrial Design”, McGraw Hill, 1992.
8. Niebel, “Product Design”, McGraw Hill, 1974.