VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM

APPLIED MATHEMATICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	16MAU11	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
Credit	04		

Course objectives: The main objective of the course is to enhance the knowledge of principles of numerical methods, partial differential equations, linear transformations, solution of linear algebraic equations and Eigen value problems with a greater accuracy required for the general applications of mechanical engineering sciences.

Modules	**Teaching Hours**
Module-1	
Approximations and round off errors: Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modeling and engineering problem solving: Simple mathematical model, Conservation laws of engineering. Roots of polynomial-polynomials in engineering and science, Muller's method, Bairstow's Method Graeffe's root squaring method.	10 Hours
Module -2	
Roots of Equations: False position method, Newton- Raphson method. Multiple roots by Newton-Raphson method. Simple fixed point iteration method- Acceleration of convergence- Δ^2 - Aitken's method. Numerical Differentiation and Numerical Integration: Newton –Cotes and Guassian Quadrature Integration formulae, Integration of Equations, Romberg integration, Numerical Differentiation Applied to Engineering problems, High Accuracy differentiation formulae.	10 Hours
Module -3	
Numerical Solution for Partial Differential Equations: Classification of second order partial differential equations. Solution of one dimensional heat equation by explicit method and Crank-Nicolson method. Solution one dimensional wave equation and two-dimensional Laplace equation by explicit method.	10 Hours
Module -4	
System of linear algebraic equations and eigen value problems: Introduction, Direct methods, Gauss elimination method, triangularization method, Cholesky method, Partition method, Error analysis for direct methods. Eigen values and eigen vectors: bounds on eigen values, Jacobi method for symmetric matrices, Givens and Householder's method for symmetric matrices. Power method and Inverse power method.	10 Hours
Module -5	
Linear Transformation: Introduction to linear transformation. The matrix of linear transformation, linear models in science and engineering. Orthogonality and least squares: inner product, length and orthogonality, orthogonal sets, orthogonal projections. Gram-Schmidt process, least-square problems, inner product	10 Hours

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Course outcomes: At the end of the course, students are able to:

1. Employ numerical techniques in order to achieve more accurate values in the computation of roots of polynomials and non-linear equations.
2. Understand vector spaces, basis, linear transformations and the process of obtaining matrix of linear transformations arising in magnification and rotation of images.
3. Utilize standard numerical schemes to solve partial differential equations applicable to mechanical engineering problems.
4. Apply the numerical linear algebra techniques to solve algebraic, transcendental and matrix eigen value problems.
   Employ the idea linear transformations, inner product spaces and orthogonality to design linear models occurring in science and engineering

Question paper pattern:

1. The question paper will have ten full questions carrying equal marks.
2. Each full question consisting of 16 marks.
3. There will be two full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Text Books:

1. S.S.Sastry: Introductory Methods of Numerical Analysis, Prentice Hall of India, 4th Edition, 2006.
2. Steven C. Chapra: Applied Numerical Methods with MATLAB for Engineers and Scientists, Tata Mcgraw Hill, 3rd Ed, 2011.
3. David C.Lay, Steven R.Lay and J.J.McDonald: LinearAlgebra and its Applications, 5th Edition, Pearson Education Ltd., 2015.

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Reference Books:

1. B.S.Grewal: Numerical methods in Engineering and Science (with C,C++,&MATLAB), Khanna Publishers, 2014.
2. M. K. Jain, S.R.K. Iyengar and R. K. Jain, "Numerical Methods for Scientific and Engineering Computation", New Age International Publishers, 9th Edition, 2014.
3. PervizMoin, Fundamentals of Engineering Numerical Analysis, Cambridge University Press, 2010.

AUTOMOIVE ENGINE AND SYSTEMS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	16MAU12	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
Credit	04		

Course objectives: At the end of the course the student will be able to:

1. Explain details of engine fuel supply system
2. Understand and explain combustion in spark ignition engine and compression ignition engine
3. Select engine cooling and lubrication systems
4. Explain Engine management system and recent developments
5. Conduct Engine testing

Modules	**Teaching Hours**
Module-1	
Introduction: Definition of a heat engine; external and internal combustion engine; basic engine components and nomenclature; the working principles of engines; classification of IC engines; application of IC engines. **Fuel Supply Systems:** **SI** Engine**:** Principle of elementary carburettor, Mixture requirements for steady state and transient operation, Gasoline Fuel Injection. **C.I. Engines:** Fuel injection pump systems- Types, constructional features and operation, Factors influencing fuel spray atomization, penetration and dispersion of diesel**,** Fuel Injection Pumps (inline, rotary), Filters, Governors – Types of Governors - fuel feed pumps and Types, injectors and nozzles – types, functions and necessities, injection lag, pressure waves in fuel lines.	10 Hours
Module -2	
Combustion in SI engines: Essential features of ignition timing and ignition voltage, MBT timing, knock detection and control strategies, thermodynamic analysis of SI engine combustion, analysis of cylinder pressure data. **Combustion in CI engines:** Essential features of injection timing and delay period, correlations for ignition delay in engines, effect of fuel properties, types of combustion chambers and merits of the different types, analysis of cylinder pressure data, fuel spray behavior.	10 Hours
Module -3	
Cooling and Lubrication System : **Cooling System**: Necessity, variation of gas temperature, Areas oh heat flow, heat transfer, piston and cylinder temperature,. Heat rejected to coolant, quantity of water required, cooling system, air cooling, water cooling, thermodynamics of forced circulation, thermostats, pressurized water cooling, regenerative cooling, comparison of air and water cooling, radiators types, cooling fan – power requirement, antifreeze solution	10 Hours

Lubrication System: Lubricants, lubricating systems, Lubrication of piston rings, bearings, oil consumption, Oil cooling. Heat transfer coefficients, liquid and air cooled engines, coolants, additives and lubricity improvers, oil filters, pumps, and crankcase ventilation – types	
Module -4	
Engine Management System: Combined ignition and fuel management systems., Digital control techniques. Complete vehicle control systems, Artificial intelligence and engine management, Exhaust emission control in SI and CI engines, Techniques **Recent Developments in Automotive Engines:** Supercharger, Working Principle, Effect of Super charging, Types and Methods of Super charging, Turbo Charger, Working Principle , Turbo-lag, VVT, V-TEC i-VTEC and IDTEC. ATFT, CRDI system – working Principle, Advantages and Effect of CRDI on emission reductions, Hybrid vehicles and fuel cells.	10 Hours
Module -5	
Engine Performance Testing: **E**ngine performance parameters; Methods of determination of BP, IP, FP, volumetric, thermal, mechanical, scavenging efficiencies, etc., types of dynamometers, Morse Test, Numerical Problems in Engine Testing , Engine Performance and heat balance sheet.	10 Hours
Course outcomes: After completion of above course, students will be able to 1. Explain details of engine fuel supply system 2. Understand and explain combustion in spark ignition engine and compression ignition engine 3. Select engine cooling and lubrication systems 4. Explain Engine management system and recent developments 5. Conduct Engine testing	
Question paper pattern: 1. The question paper will have ten questions. 2. Each full question consists of 16 marks. 3. There will be twofull questions (with a maximum of four sub questions) from each module. 4. Each full question will have sub questions covering all the topics under a module. 5. The students will have to answer 5 full questions, selecting one full question from each module.	
Text Books: 1. Internal Combustion Engine Fundamentals-John B.Heywood, McGraw-Hill Book Company(1988) 2. Introduction to Internal Combustion Engines-Dr.K. K. Ramalingam, ScitechPublication, 2004 3. Internal Combustion Engines- V.Ganesan, Tata McGraw Hill Publications.	
Reference Books: 1. Automotive Electrical and Electronics- Tom Denton , SAE, 2000 2. Advanced Engine Technology- Heinz Heisler, SAE Publications, 1995. 3. Internal Combustion Engine Hand Book- Richard Van Basshuysen, Fred Schaefer, SAE(2004)	

NOISE, VIBRATION AND HARSHNESS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	16MAU13	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
Credits	04		

Course objectives: At the end of the course the student will be able to:

1. Explain principleof the design aspects for NVH in cars.
2. Identify the sources of noise and vibration in cars and the path of transmission of noise.
3. Conduct testing of vehicle components for vibrations.

Modules	**Teaching Hours**
Module-1	
Fundamentals of sound: Definition of NVH, Vehicle noise - Direct sound generation mechanism: airborne sound; Indirect sound generation mechanism: structure borne sound; Subjective response sound, Acoustic variables, basic attributes of sound such as wavelength, period, frequency; speed of sound, Decibel scale, Wave equation, types of sound fields, Measures of sound: Sound pressure, sound intensity and sound power, Combining sources: dB arithmetic, Standing wave, Beating, Impedance, Human hearing: frequency Versus sound pressure level, Loudness: phons and sones as noise descriptors; Weighting networks, Leqand various noise metrics for road noises.	10 Hours
Module -2	
Noise measurements and instrumentation: Measuring microphones, Sound level meter, time and frequency weighting, Sound spectra – Octave band analysis, Order analysis and waterfall plot, Various types of acoustic testing chambers, Sound power measurement from Sound pressure: Free field method, Reverberant field method, Semi- Reverberant field method and Comparison method (using calibrated Sources) Two- microphone probe for measuring; Sound power measurement from Sound Intensity	10 Hours
Module -3	
Sound fields and Room Acoustics: Characterizing sound sources; Directivity; Sound Fields; Various approaches to modeling sound sources; Transmission loss (TL) and Insertion loss (IL); Reverberation time and Acoustic Absorption Coefficient; Effects of leaks on barrier and TL of composite barriers; measurement Absorption Coefficient and Transmission loss (TL). **Vehicle Interior and Exterior noise:** Internal noise sources in vehicles such as engine noise; road noise; aerodynamic (wind) noise; brake noise; squeak, rattle and tizz noises; sound package solution to reduce the interior noise: acoustic isolation, acoustic absorption and damping material solutions; Exterior noise sources in vehicles such as air intake systems and exhaust systems; Tyre noise.	10 Hours
Module -4	

Sources of Vehicle vibration: Power train and Engine vibrations; driveline vibrations; chassis and suspension vibrations; Control strategies; Human response to vehicle vibrations, concept of harshness; subjective and objective evaluation of vehicle harshness. **Vibration Isolation and Control:** Introduction; damping of vibrations; vibration isolation and absorption; design of a Vibration Absorbers, unconstrained and constrained layer damping treatment, add on dampers and stiffeners, Introduction to Active Vibration Control.	10 Hours
Module -5	
Vibration Measurement and Instrumentation: Definition of Modal Properties, Modal analysis theory, FE & Experimental modal analysis, Transducers and accelerometers Excitation sources Impact Excitation, Shaker excitation, Excitation signals, applications of Modal Analysis, laser based vibration measurements; analysis and presentation of vibration data.	10 Hours

Course outcomes: After completion of above course, students will be able to

1. Explain principleof the design aspects for NVH in cars.
2. Identify the sources of noise and vibration in cars and the path of transmission of noise.
3. Conduct testing of vehicle components for vibrations.

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2 full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Engineering Noise Control: Theory and Practice- Bies D A and Hansen C H, Spon Press, Taylor &Francis, NYUSA, 2003.
2. Vehicle Noise & Vibration Refinement -Xu Wang, Elsevier Publishing Limited, 2010.
3. Mathew Harrison Vehicle Refinement- Controlling Noise & Vibration in Road Vehicles, Elsevier Publication(2004).

Reference Books:

1. Theory and Problems of Mechanical Vibrations - William W. Seto, McGraw Hill International BookCo., Singapore (Schaum's outline series)
2. Mechanical Vibrations - S. S. Rao, Pearson Education Inc.,
3. Mechanical Vibrations - S. Graham Kelly, Schaum's Outline Series, Tata McGraw Hill Publishing Co.Ltd., New Delhi.

ADVANCED MACHINE DESIGN

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	16MAU14	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
Credits	04		

Course objectives: At the end of the course the student will be able to:

1. Design machine components which are subjected to fluctuating loads.
2. Use LEFM approach for crack growth determination.
3. Design machine components/parts based on creep criterions. They are able to implement the concept of reliability for designing a machine parts or machine.
4. Explain the contact stresses and implementation of Hertz contact phenomenon to the real field problem. Identify failure modes and evolve design by analysis methodology.
5. Design against fatigue failure is given explicit attention.

Modules	**Teaching Hours**
Module-1	
Introduction: Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr's theory and modified Mohr's theory, Numerical examples. Fatigue of Materials: Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods ,Fatigue design criteria, Fatigue testing, Test methods and standard test specimens, Fatigue fracture surfaces and macroscopic features, Fatigue mechanisms and microscopic features.	10 Hours
Module -2	
Stess-Life (S-N) Approach: S-N curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behaviour, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using SN approach. **Strain-Life(ε-N)approach:** Monotonic stress-strain behavior ,Strain controlled test methods ,Cyclic stress strain behavior ,Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by ε-N approach.	10 Hours
Module -3	
LEFM Approach: LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation. Notches and their effects: Concentrations and gradients in stress and strain, S-N approach for notched membranes, mean stress effects and Haigh diagrams, Notch strain analysis and the strain – life approach, Neuber's rule, Glinka's rule, applications of fracture mechanics to crack growth at notches.	10 Hours
Module -4	

Fatigue from Variable Amplitude Loading: Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation using stress life approach.	10 Hours
Module -5	
Surface Failure: Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength.	10 Hours

Course outcomes: After completion of above course, students will be able to

1. Design machine components which are subjected to fluctuating loads.
2. Use LEFM approach for crack growth determination.
3. Design machine components/parts based on creep criterions. They are able to implement the concept of reliability for designing a machine parts or machine.
4. Explain the contact stresses and implementation of Hertz contact phenomenon to the real field problem. Identify failure modes and evolve design by analysis methodology.
5. Design against fatigue failure is given explicit attention.

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Metal Fatigue in engineering- Ralph I. Stephens, Ali Fatemi, Robert, Henry o. Fuchs, JohnwileyNewyork, Second edition. 2001.
2. Failure of Materials in Mechanical Design- Jack. A. Collins, John Wiley, Newyork 1992.
3. Machine Design- Robert L. Norton , Pearson Education India, 2000

Reference Books:

1. Fatigue of Materials- S .Suresh , Cambridge University Press, -1998
2. Fundamentals of Metal Fatigue Analysis - Julie.A.Benantine, Prentice Hall,1990
3. Fatigue and Fracture, ASM Hand Book, Vol. 19, 2002.

AUTOMOTIVE MATERIALS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	16MAU151	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
Credits	03		

Course objectives: At the end of the course the student will be able to:

1. Explain use of conventional automotive materials, their properties and testing methods.
2. Explain composite material their classifications, applications and manufacturing techniques and able to select composits for given application.
3. Perform Micro and macro mechanical analysis of a lamina.
4. Select materials for various automotive components and manufacturing techniques for a broad range of materials.

Modules	Teaching Hours
Module-1	
Aluminium Alloys & Lightweight Magnesium for Automotive Applications: Introduction; Wrought Aluminum alloys; Cast aluminum processes Technologies; Cast aluminum metallurgy and properties; New Lightweight alloys; Process technologies; mechanical and physical properties; Case studies of applications. **Testing Automotive Materials:** Evaluation of materials under realistic loading and environmental conditions; different test methods for evaluation of properties for specific applications.	08 Hours
Module -2	
Composite Materials for Automotive Applications: Definition, Classification, Types of matrices & reinforcements, characteristics & selection, Fiber composites, laminated composites, particulate composites, prepegs, sandwich construction. **Manufacturing Composite Materials:** Lay up and curing – open and closed mould processing – Hand lay –up techniques – Bag moulding and filament winding. Pultrusion, pulforming, Thermoforming, Injection moulding, Cutting, Machining and joining, tooling, Quality assurance – Introduction, material qualification, types of defects, NDT methods.	08 Hours
Module -3	
Metal matrix composites: Reinforcement materials, types, Characteristics & selection, base metals, selection, applications in automotive engineering.	08 Hours
Module -4	
Micro mechanical analysis of a lamina: Introduction, Evaluation of the four elastic modules – Rule of mixture, ultimate strengths of unidirectional lamina. **Macro mechanics of a lamina:** Hooke's law for different types of materials, number of elastic constants; Two – dimensional relationship of compliance & stiffness	08 Hours

matrix. Hooke's law for two dimensional angle lamina, engineering constants – angle lamina, Invariants, Theories of failure.	
Module -5	
Macro Mechanics of Laminates: Laminates Coding, ABD Matrices, Classical Laminates Theory, Special cases of Laminates, Strength Theories of Laminates.	08Hours

Course outcomes: After completion of above course, students will be able to

1. Explain use of conventional automotive materials, their properties and testing methods.
2. Explain composite material their classifications, applications and manufacturing techniques and able to select composits for given application.
3. Perform Micro and macro mechanical analysis of a lamina.
4. Select materials for various automotive components and manufacturing techniques for a broad range of materials.

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Developments in Lightweight Alloys for Automotive Applications-James M Boileau, 2001-2005, SAE (Product Code PT-130).
2. Lightweight Magnesium Technology-ThomesRuden, 2001 through 2005, SAE (Product code PT-131)

Reference Books:

1. Testing Automotive Materials & Components - Donald H Wright, SAE (Product Code R – 124)
2. Composite material science and Engineering- Krishan K. Chawla, Springer.
3. Fibre reinforced composites- P. C. Mallik , Marcel Decker.

AUTOMOTIVE CONTROL SYSTEM

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	16MAU152	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
Credits	03		

Course objectives: At the end of completion of this course, students will be able

1. Explain basics and different types of control system required for the Automotive vehicle for improvement of performance of vehicle
2. To gain knowledge of safety and security systems
3. To study improvement of Comfort and Vehicle Control System
4. To understand the Intelligent Transportation System.

Modules	Teaching Hours
Module-1	
Chassis and Drive Line Control: Components of chassis management system – role of various sensors and actuators pertaining to chassis system – construction – working principle of wheel speed sensor, steering position, tyre pressure, brake pressure, steering torque, fuel level, Engine and vehicle design data **Drive Line Control:** Speed control – cylinder cut - off technology, Gear shifting control – Traction / braking control, brake by wire – Adaptive cruise control, throttle by wire. Steering - power steering, collapsible and tiltable steering column – steer by wire	08 Hours
Module -2	
Engine Management System: Basic Engine Operations – Fuel Control, Ignition control, Lambda Control, Idle Speed Control, Knock Control , Open Loop and Closed Loop Control **Sensors:** Basic sensor arrangement; Types of sensors such as oxygen sensors, Crank angle position sensors, fuel metering/vehicle speed sensors and detonation sensors, altitude sensors, flow sensors, throttle position sensors, solenoids,	08 Hours
Module -3	
Safety and Security Systems: Airbags, seat belt tightening system, collision warning systems, child Lock, anti-lock braking systems, Vision enhancement – Static and dynamic bending of Head light, road recognition system, Anti-theft technologies, smart card system, number plate coding, central locking system.	08 Hours
Module -4	
Comfort and Vehicle Control System: Active suspension systems, requirement and characteristics, different types, Vehicle Handling and Ride characteristics of road vehicle, pitch, yaw, bounce control, power windows, adaptive noise control. ABS Control System – Torque Balance at Wheels road contact – Control	08 Hours

cycle of ABS System – Advantages – Traction control system- Combination of ABS with Traction control system.	
Module -5	
Intelligent Transportation System: Traffic routing system - Automated highway systems - Lane warning system – Driver Information System, driver assistance systems - Data communication within the car, Driver conditioning warning - Route Guidance and Navigation Systems – vision enhancement system - In-Vehicle Computing – Vehicle Diagnostics system. VANET usage in Automobiles	08 Hours
Course outcomes: At the end of the course students will be able to 1. Explain basics and different types of control system required for the Automotive vehicle for improvement of performance of vehicle 2. To gain knowledge of safety and security systems 3. To study improvement of Comfort and Vehicle Control System 4. To understand the Intelligent Transportation System.	
Question paper pattern: 1. The question paper will have ten questions. 2. Each full question consists of 16 marks. 3. There will be 2full questions (with a maximum of four sub questions) from each module. 4. Each full question will have sub questions covering all the topics under a module. 5. The students will have to answer 5 full questions, selecting one full question from each module.	
Text books: 1. Automotive Control Systems- U. Kiencke, and L. Nielsen, SAE and Springer-Verlag, 2000. 2. Intelligent Vehicle Technologies- LjuboVlacic, Michel Parent, Fumio Harashima, Butterworth- Heinemann publications,Oxford, 2001.	
Reference Books: 1. Automotive Mechanics- Crouse, W.H. &Anglin, D.L., Intl. Student edition, 9th edition, TMH, New Delhi, 2002. 2. Understanding Automotive Electronics- William B.Ribbens -5th edition, Butter worth Heinemann Woburn,1998. 3. Automotive HandBook- Bosch, 8th edition, SAE, 2007.	

VEHICLE MAINTENANCE AND FLEET MANAGEMENT

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	16MAU153	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
Credits	03		

Course objectives: At the end of the course the student will be able to:

1. Explain standard tools and records used in vehicle maintenance shops.
2. ExplainImportance of maintenance and different types of maintenance.
3. device Power Plant Repair and Overhauling schedule
4. Explain MV acts and legal aspects of transportation.

Modules	**Teaching Hours**
Module-1	
Maintenance Tool, Shop, Schedule, Records: Standard tool set, torque wrenches, compression and vacuum gauges, engine analyzer and scanner, computerized wheel alignment and balancing, gauges for engine tune up and pollution measurement, spark plug cleaner, cylinder re boring\ machine, fuel injection calibration machine.	08 Hours
Module -2	
Importance of maintenance: Schedule and unscheduled maintenance. Scope of maintenance. Equipment downtime. Vehicle inspection. Reports. Log books. Trip sheet. Lay out and requirements of maintenance shop.	08 Hours
Module -3	
Power Plant Repair and Overhauling: Dismantling of power plant and its components. Cleaning methods. Inspection and checking. Repair and reconditioning methods for all engine components. Maintenance of ignition system, fuel injection system, cooling system- lubrication system. Power plant trouble shooting chart.	08 Hours
Module -4	
The Concept of Transport: The means of transport, classifications, and road transport - advantages of road transport, advantages of motor transport, and motor transport in India - types of road and their features. Transit Operation: Route planning - route location, stop location, route schedules, vehicle and labor scheduling, traffic control - traffic signals, signal timing, freeway control systems. **Forms Of Ownership:** Sole proprietorship, partnership, private limited company, public limited company, statutory company, local authority undertaking / municipal transport company, joint venture. **Costs and Fares:** Operating costs and types of vehicles - production economics,	08 Hours

requirement of buses and frequency, garages and bus stations, garage organisation, construction of bus station.	
Module -5	
Legal Aspects: Motor vehicle act- registration, necessity of permits, insurance, test of competence to drive, mistake / offences for which a driver can be punished, adult workers - hours of work, running time, split duty, journey time, round journey time, layover, frequency.	08 Hours

Course outcomes: At the end of the course the student will be able to

1. Explain standard tools and records used in vehicle maintenance shops.
2. ExplainImportance of maintenance and different types of maintenance.
3. device Power Plant Repair and Overhauling schedule
4. Explain MV acts and legal aspects of transportation.

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Motor Vehicle Servicing- A.W. Judge, 3rd Edition, Pitman Paperpack, London, 1969.
2. Everyday Automobile repair- W. Crouse, Intl.student edition, TMH, New Delhi, 1986.
3. Fleet management- John Dolu, McGraw-Hill Co., 1984.
4. Government of India Publication, "The Motor vehicle Act ", 1989.

Reference Books:

1. Bus operation - Kitchin L D, llliffe and Sons Ltd., London, III Edition, 1992.
2. Spicer,-Automobile collision Work - Frazee, fledell, American technical publications, Chicago,1953.
3. Maintenance of high speed diesel engines- A, W. Judge, Chapman Hall Ltd., London, 1956.
4. Diesel Engine operation and maintenance- V. L. Maleev, McGraw Hill Book CO., New york, 1995.

AUTOMOTIVE EMBEDDED SYSTEMS [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Subject Code	16MAU154	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
Credits	03		

Course objectives: At the end of the course the student will be able to:

1. Explain basics of Automotive Embedded system concepts,
2. Explaindifferent application of embedded system in automotive and
3. Use hardware and usage software in Automotive Embedded System
4. Use different software development tools
5. Explain integration of Software and Hardware

Modules	Teaching Hours
Module-1	
Electronics in Automotive: Introduction Body and convenience electronics: vehicle power supply controllers and lighting modules, door control modules, Safety electronics: active safety systems: ABS, ASR, ESP passive safety systems: Restraint systems and their associated sensors in an automobile. Powertrain Electronics: Gasoline engine management, Infotainment electronics: Dashboard/instrument cluster, car audio, telematic systems, navigation systems, multimedia systems, cross application technologies. 42V vehicle power supply system.	08 Hours
Module -2	
Drive by Wire: Challenges and opportunities of X-by-wire: system & design requirements steer-by-wire, brake-by-wire, suspension-by-wire, gas-by-wire, power-by-wire, shift by-wire. Future of Automotive Electronics	08 Hours
Module -3	
HARDWARE MODULES: MC9S12XD family features -Modes of operation-functional block diagram overview-programming model. Memory Map Overview Pulse Width Modulator (PWM) –On-chip ADC Serial Communication Protocol: SCI, SPI,IIC, CAN.	08 Hours
Module -4	
Software Development Tools: Introduction to HCS12XDT512 Student Learning Kit & PBMCU (Project Board) –Introduction to Code Warrior IDE-Editing-Debugging-Simulating simple programs. Flashing code into HCS12XDT512 SLK board and testing	08 Hours
Module -5	
Integration of Software and Hardware: Downloading the Software from Host Machine to Target Machine. Implementing application prototype: Power Window and Automotive	08 Hours

Lighting System	

Course outcomes:

After completion of above course, students will be able to

1. Explain basics of Automotive Embedded system concepts,
2. Explain different application of embedded system in automotive and
3. Use hardware and usage software in Automotive Embedded System
4. Use different software development tools
5. Explain integration of Software and Hardware

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text books:

1. Semiconductors-Technical Information, Technologies and characteristic data, PublicisCorporatePublishing 2nd revised and considerably enlarged edition, 2004,
2. Freescale MC9S12XDP512 data sheet
3. Automotive Electronics Handbook- Ronald K Jurgen , McGraw Hill , 2000.
4. Semiconductors: Technical Information, Technologies and Characteristic Data- Werner Klingenstein& Team, Publicis Corporate Publishing, 2nd edition, 2004
5. Intelligent Vehicle Technologies: Theory and Applications- LjuboVlacic, Michel Parent &FurnioHarshima, , Butterworth-Heinemann publications, 2001.

AUTOMOTIVE ENGINEERING LAB –I [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Subject Code	16MAU16L	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	36	Exam Hours	03
Credits	02		

List of Experiments

1	Linear Static (Stress) Analysis of Automotive Engine Components such as Connecting Rod, Piston, Cylinder wall, Crank Shaft using FEA software Such as MSC Patran / MSC Nastran and etc
2	Modal Analysis of Automotive Engine Components using FEA software
3	Dynamics Analysis of Automotive Engine Components using FEA Software
4	Heat Transfer Analysis of Automotive Engine Components using FEA Software
5	Random Vibration analysis
6	Testing of Single Cylinder, Twin Cylinder and multi cylinder SI / CI engines for performance, Calculate BP, Thermal, volumetric efficiencies, and BSFC with emission testing
7	Conduct Morse test for finding FP, IP, Indicated thermal efficiency and Mechanical efficiency and tuning the engine parameters
8	Performance test on computerized IC engine test rig using conventional fuels and Alternate Fuels.
9	Study and tuning of CRDI engine
10	Performance test on Variable Compression Ratio Engine

SEMINAR ON CURRENT TOPICS **[As per Choice Based Credit System (CBCS) scheme]** **SEMESTER – I**			
Subject Code	16MAU17	IA Marks	100
Number of Practical/ Field /assignments Hours/Week	03	Exam Marks	--
Credits	01	Exam Hours	--
Students should make presentation on current scenario/ latest technologies in Automotive Engineering			

AUTOMOTIVE POWER TRAINS
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Subject Code	16MAU21	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
Credits	04		

Course objectives: At the end of the course the student will be able to:

1. Explain layout and components of automotive transmission.
2. Explain detailed concept, construction and principle of operation of various types of mechanical transmission components, hydrodynamic devices, and hydrostatic devices.
3. Select of automatic transmission system.
4. Explain differential, final drives and the design of other transmission elements

Modules	Teaching Hours
Module-1	
Overview of Vehicle Powertrains System: Outlines of Power Trains, Power train functions, Power train layout and components, Main and Auxiliary functions, Requirements profile, Interrelations: Direction of rotation, Transmission Ratio and Torque, Road Profiles, Load Profiles, Typical Vehicle uses and Driver types, Performance features of Vehicle Transmissions. Design trends in Transmission, Kinematical relations of powertrains, Numerical problems. **Matching engine and transmission:** Road loads and axle loads, Deriving condition diagram, Ideal transmission and engine-transmissions matching, Total ratio and overall gear ratio- Selecting the largest power- train ratio, Selecting the smallest power- train ratio, Selecting the intermediate gears- saw tooth profile, Geometrical gear steps, Progressive gear steps, Numerical problems.	10 Hours
Module -2	
Start-up Devices: One -way clutch, Band clutch, Multi-disk clutch, Clutch Design and Analysis, Hydrodynamic Clutches and Torque Converters: Principles, Characteristic curves of Hydrodynamic Clutches, Construction and operation of Torque Converter, Input/output characteristics, Design Considerations, Trilok Converter, Torque Converter test diagram, Interaction of engine and Trilok Converter, Numerical problems.	10Hours
Module -3	
Manual Transmissions: Manual Transmission Layouts and Components, Basic gear box construction, gear-sets with fixed axles, countershaft transmission and epicyclic gears, schemes for reverse gear. Transmission Power Flows, Numerical problems.	10 Hours

Gear shifting mechanisms, Layout and design of Synchronizers: Internal shifting mechanisms and External shifting mechanisms, Classification of shifting elements, synchronizer functional requirements, synchronizing process, design of synchronizers, alternative transmission synchronizers	
Module -4	
Automatic Transmissions: Level of automation, Gear shift mode, stepped and Continuously Variable Transmissions, synchronizer gear boxes, epicycloidal gear boxes, Car CVT'S: Van Doorne Continuously Variable Transmission (CVT) and Torotrak Continuously Variable Transmission (CVT). Design and analysis of planetary gear trains, Gear ratios and clutch engagement schedule, Clutch torques in steady state condition, Torque analysis in shifting process, Numerical problems.	10 Hours
Module -5	
Differential and Final drives: Outline of differential theory-friction free differential, Differential with internal friction, Self locking differential, final drives: formats, performance limits, transmission ratios. Differential gears, differential locks and locking differentials, types of self locking differential, Numerical problems. **Design of other Transmission elements:** Design of slip joint, universal joint, dead & live axle, constant velocity joints, Bearing Design, Selection of ball and roller bearing, Gear box housing design.	10 Hours
Course outcomes: After completion of above course, students will be able to 1. Explain layout and components of automotive transmission. 2. Explain detailed concept, construction and principle of operation of various types of mechanical transmission components, hydrodynamic devices, and hydrostatic devices. 3. Select of automatic transmission system. 4. Explain differential, final drives and the design of other transmission elements	
Question paper pattern: 1. The question paper will have ten questions. 2. Each full question consists of 16 marks. 3. There will be 2full questions (with a maximum of four sub questions) from each module. 4. Each full question will have sub questions covering all the topics under a module. 5. Use of Design data handbook is permitted in examination. 6. The students will have to answer 5 full questions, selecting one full question from each module.	
Reference Books: 1. Automotive Transmissions: Fundamentals, Selection, Design and Application, GisbertLechner, HaraldNaunheimer, Springer-Verlag Berlin Heidelberg, New York, ISBN 3-540-65903. 2. Design Practices: Passenger Car Automatic Transmissions, Many authors, Third Edition, AE-18, SAE, Warrendale, 1994. 3. Handbook of Automotive Powertrain and Chassis Design- J. Fenton, Professional Engineering Publishing, London 1998. 4. Gears and Transmissions, Vol. 4- J.G. Giles, Automotive Technology series, Butterworth, London 1969.	

AUTOMOTIVE BODY ENGINEERING AND SAFETY
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Subject Code	16MAU22	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
Credits	04		

Course objectives: At the end of the course the student will be able to:

1. Explain construction of vehicle, aerodynamic, concept, paneling of passenger car body trim.
2. ClassifyChassis layouts of passenger and commercial vehicles
3. ExplainBody Materials, trim, mechanisms in vehicles.
4. Design and construction of external body of the vehicles
5. Study the concepts of Steering Dynamics and Suspension Mechanisms

Modules	**Teaching Hours**
Module-1	
Introduction: Types of car bodies, bus bodies and commercial vehicle bodies. **Interior Ergonomics:** Introduction, Seating dimensions, Interior ergonomics, ergonomics system design, seat comfort, requirements of drivers and passenger seats, suspension seats, split frame seating, back passion reducers, dash board instruments, electronic displays, commercial vehicle cabin ergonomics, mechanical package layout, goods vehicle layout. Visibility, regulations, drivers visibility, methods of improving visibility, Window winding and seat adjustment mechanisms.	10 Hours
Module -2	
Aerodynamics: Basics, Vehicle drag and types, Various types of forces and moments, effects of forces and moments, various body optimization techniques for minimum drag, Principle of wind tunnel technology, flow visualization techniques, tests with scale models, aerodynamic study for heavy vehicles. **Body Materials, Trim, Mechanisms:** Steel sheet, timber, plastic, GRP, properties of materials - Corrosion - Anticorrosion methods – Selection of paint and painting process - Body trim items - Body mechanisms.	10 Hours
Module -3	
Noise and vibration: Noise characteristics, Sources of noise, sound measurement techniques: Sound level meter, time and frequency weighting, Sound spectra – Octave band analysis, Various types of acoustic testing chambers, Sound power measurement from Sound pressure: Free field method, Reverberant field method, Semi- Reverberant field method and Comparison method (using calibrated Sources) Two- microphone probe for measuring; Sound power measurement from Sound Intensity, Body	10 Hours

structural vibrations, chassis bearing vibration, designing against fatigue, methods of noise suppression.	
Module -4	
Body Loads and Design of Vehicle Bodies: Idealized structure- structural surface, shear panel method, symmetric and asymmetrical vertical loads in car, longitudinal loads, different loading situations. **Vehicle Layout design:** preliminary design, Load distribution on vehicle structure, stress analysis of bus body structure under bending and torsion, stress analysis in integral bus body, Design of chassis frame, Rules and regulations for body, Recent safety measures, Testing of body.	10 Hours
Module -5	
Vehicle safety: Active and passive safety, Restraint systems used in automobiles: safety belts, Head restraints, Air bags, Knee bolsters, Importance of Bumpers and their design, Types of safety glass and their requirements, Importance of Ergonomics in Automotive safety- Locations of controls. **Vehicle structures for crash worthiness:** Types of crash / roll over Tests, Regulatory requirements for crash testing, Instrumentation, high speed photography, Image Analysis.	10 Hours

Course outcomes:

After completion of above course, students will be able to

1. Explain construction of vehicle, aerodynamic, concept, and paneling of passenger car body trim.
2. Classify Chassis layouts of passenger and commercial vehicles
3. Explain Body Materials, trim, mechanisms in vehicles.
4. Design and construction of external body of the vehicles
5. Study the concepts of Steering Dynamics and Suspension Mechanisms

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text books:

1. Vehicle Body Engineering-Pawloski J., Business Books Ltd.
2. The automotive chassis: Engineering principle - Reimpell J, 2nd Edition, 1983.
3. Low speed Automobile Accidents -Watts, A. J., et al Lawyers and Judges 1996
4. An Introduction to Modern Vehicle Design- JullianHappian-Smith SAE, 2002

AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Subject Code	16 MAU23	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
Credits	04		

Course objectives: At the end of the course the student will be able to:

1. Explain principles of storage batteries used in Automobiles.
2. Explain different charging and lighting systems.
3. Select differentIgnition systems and Engine Management Systems.
4. Explain different advanced electrical and electronic systems.

Modules	**Teaching Hours**
Module-1	
Storage Battery: Principle of lead acid cells, plates and their characteristics containers and separators, electrolyte and their preparation, effect of temperature on electrolyte, its specific gravity, capacity and efficiency, methods of charging from D.C. mains, defects and remedies of batteries, care of idle and new batteries. Recycling Process - Recent development in batteries **Charging :** D.C. Generators and Alternators their Characteristics. Control cutout, Electrical, Electro-mechanical and electronic regulators. Regulations for charging	10 Hours
Module -2	
Lighting System Wiring Requirements, Insulated and earth return system, details of head light and side light, LED lighting system, wiring colour code, Sealed beam head lamp construction, head light dazzling and preventive methods. Static and Dynamic Beaming of lights. **Starter Motor & Drives:** Battery motor starting system, condition at starting, behavior of starter during starting, series motor and its characteristics, consideration affecting size of motor, types of drives, starting circuit.	10 Hours
Module -3	
Ignition systems and Engine Management Systems: Ignition fundamentals, Types of solid state ignition systems, components, construction and operating parameters, high energy ignition distributors, Electronic spark timing, Ignition Advance, Types DIS, MBT and control. Combined ignition and fuel management systems. Exhaust emission control, Digital control techniques – Dwell angle calculation, Ignition timing calculation and Injection duration calculation. Complete vehicle control systems, Artificial intelligence and engine management	10 Hours
Module -4	
Chassis systems:	10 Hours

Antilock brakes (ABS), Types , Active suspension, Traction control, Electronic control of automatic transmission, other chassis electrical systems, Central locking, Air bags and seat belt tensioners. Microprocessor And Microcomputer controlled devices in automobiles such as instrument cluster, Voice warning system, Travel information system, GPS, AUTOCOP , Keyless entry system	
Module -5	
Accessories: Warning and alarm instruments: Brake actuation warning system, traficators, flash system, oil pressure warning system, engine over heat warning system, air pressure warning system, speed warning system, door lock indicators, neutral gear indicator, horn design, permanent magnet horn, air & music horns. Wind shield wiper. window washer, instrument wiring system and electromagnetic interference suppression, wiring circuits for instruments, electronic instruments, dash board illumination and MIL.	10 Hours
Course outcomes: After completion of above course, students will be able to 1. Explain principles of storage batteries used in Automobiles. 2. Explain different charging and lighting systems. 3. Select differentIgnition systems and Engine Management Systems. 4. Explain different advanced electrical and electronic systems.	
Question paper pattern: 1. The question paper will have ten questions. 2. Each full question consists of 16 marks. 3. There will be 2full questions (with a maximum of four sub questions) from each module. 4. Each full question will have sub questions covering all the topics under a module. 5. The students will have to answer 5 full questions, selecting one full question from each module.	
Text Books: 1. Modern Electrical Equipment of Automobiles - Judge A.W., Chapman and Hall, London ,1992 2. Understanding Automotive Electronics - William B. Ribbens, 5th edition- Butter worth Heinemann, 1998 3. Automobile Electrical Equipment - Young. A. P.,& Griffiths. L., English Language Book Society & New Press, 1990.	
Reference Books: 1. Automotive Hand Book -Bosch, SAE, 8th Edn. 2. Storage Batteries - Vinal. G.W., John Wiley & Sons inc., New York, 1985. 3. Automobile Electrical Equipment – Crouse W. H., McGraw Hill Book Co Inc., New York, 1980. 4. Electrical Ignition Equipment – Spread bury F. G., Constable & Co Ltd., London, 1962. 5. Automotive Computers and Digital Instrumentation - Robert N Brady, Prentice Hall, Eagle Wood Cliffs, New Jersey, 1988.	

VEHICLE DYNAMICS [As per Choice Based Credit System (CBCS) scheme] SEMESTER – II			
Subject Code	16MAU24	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
Credits	04		

Course objectives: At the end of the course the student will be able to:

1. Explain basics of vibrations
2. Analyze forces acting and the performance characteristics of tyres and brakes
3. Analyze vehicle dynamics and its influence on the vehicle handling characteristics
4. Explain principles of Steady State Handling Characteristics of Road Vehicles

Modules	Teaching Hours
Module-1	
Basics of Vibration: Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Un-damped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification factor, Transmissibility, Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed. Modal analysis.	10 Hours
Module -2	
Tyres: Tyre forces and moments, Tyre structure, Longitudinal and Lateral force at various slip angles, rolling resistance, Tractive and cornering property of tyre. Performance of tyre on wet surface. Ride property of tyres. Magic formulae tyre model, Estimation of tyre road friction. Test on Various road surfaces. Tyre vibration.. **Braking Performance:** Basic equations, Braking forces, Brakes, Brake Proportioning, Antilock Brake system, Braking efficiency, Rear wheel lockup, Standards and Legislations, Numerical Examples.	10 Hours
Module -3	
Vertical Dynamics: Human response to vibration, Sources of Vibration. Design, analysis and computer simulation of Passive, Semi-active and Active suspension using Quarter car, half car and full car model. Influence of suspension stiffness, suspension damping, and tyre stiffness. Control law for LQR, H-Infinite, Skyhook damping. Air suspension system and their properties. **Vehicle Aerodynamics:** Aerodynamic, Aerodynamic forces lift and drag components, Pitching, yawing, rolling moments, and Total road loads, Numerical Examples.	10 Hours
Module -4	
Steady State Handling Characteristics of Road Vehicles;	10 Hours

Steering Geometry, Derivation of fundamental equation governing the steady-state handling behavior of a road vehicle, Neutral Steer, Understeer and Oversteer characteristics, characteristic and critical speeds, Neutral Steer Point, Static margin, Steady-State Response to Steering Input-Yaw Velocity Response, Lateral Acceleration Response, Sideslip Response and Curvature Response; Numerical Problems. **Performance Characteristics of Off-Road Vehicles:** Drawbar Performance - Drawbar Pull and Drawbar Power, Tractive Efficiency, Coefficient of Traction, Weight-to-Power Ratio for Off-Road Vehicles; Fuel Economy of Cross-country Operations Transport Productivity and Transport Efficiency, Mobility Map and Mobility Profile, Selection of Vehicle Configurations for Off-Road, Numerical Problems	
Module -5	
Suspension Mechanisms: Solid Axle Suspension, Independent Suspension, Roll Center and Roll Axis, Car Tire Relative Angles, Toe, Caster Angle, Camber, Trust Angle, Suspension Requirements and Coordinate Frames, Kinematics Requirements, Dynamic Requirements, Wheel, wheel body, and tyre Coordinate Frames, Caster Theory, Numerical examples	10 Hours
Course outcomes: After completion of above course, students will be able to 1. Explain basics of vibrations 2. Analyze forces acting and the performance characteristics of tyres and brakes 3. Analyze vehicle dynamics and its influence on the vehicle handling characteristics Expalin principles of Steady State Handling Characteristics of Road Vehicles	
Question paper pattern: 1. The question paper will have ten questions. 2. Each full question consists of 16 marks. 3. There will be 2full questions (with a maximum of four sub questions) from each module. 4. Each full question will have sub questions covering all the topics under a module. 5. The students will have to answer 5 full questions, selecting one full question from each module.	
Text books: 1. Vehicle Dynamics: Theory and Applications-Reza N. Jazar, Springer Verlag. 2. Theory of Ground Vehicles-J. Y. Wong, John Willey&Sons,NY. 3. Fundamentals of Vehicle Dynamics- T D Gillespie, SAE 4. Tyres, Suspension, and Handling - John C. Dixon, , 2nd Edition, Society of Automotive Engineers Inc, 1996.	
Reference Books: 1. Tyre and Vehicle Dynamics- Hans B. Pacejka, SAE 2. Motor Vehicle Dynamics: Modeling and Simulation - Giancarlo Genta, World Scientific Publishing Co.; Singapore. 3. Aerodynamics of Road Vehicles - Hucho W. H. SAE. 4. Fundamentals of Vehicle Dynamics - Thomas D. Gillespie, Society of Automotive Engineers Inc, 1992 5. Vehicle Dynamics and Control - Rajesh Rajamani, 1st edition, Springer, 2005 6. Mechanical Vibrations- Singiresu S. Rao, (5th Edition), Prentice Hall, 2010	

MULTI BODY DYNAMICS
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Subject Code	16MAU251	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
Credits	03		

Course objectives: At the end of the course the student will be able to:

1. To explain different dynamics of Automotive system and basics behind the multi body dynamics**.**
2. Explain Rigid body and kinematic constraints
3. Generatemultibody codes, static and inverse dynamics
4. Do modal analysis by using MBD softwares.

Modules	**Teaching Hours**
Module-1	
Introduction to MBD, Notation. Kinematics of free bodies: point mass and rigid body. Position,velocity, acceleration. Angular orientation descriptions: transformation matrices, Euler angles, cardanangles, quaternion (Euler parameters). Kinematic equations of rotation.	08 Hours
Module -2	
Conservative and non-conservative force and torque elements. Spring, damper, bushing, forceelements with inner dynamics. Constraint forces. Impacts. The problem with play and dry friction	08 Hours
Module -3	
Rigid Body and Kinematic Constraints: Rigid body kinetics. Newton-Euler equations. Inertia tensor. Inertial and body- fixed description. State space description of multi-body systems. Kinematic constraints. Constraints functions. Degrees of freedom. Jacobian. Basic types of joints and linkages	08 Hours
Module -4	
Structure and functionality of multi- body codes. Kinematics equilibrium points (static), dynamics, Inverse dynamics.	08 Hours
Module -5	
Linearization, modal analysis, and optimization. Usage of Software such as MSC ADAMS for multi body dynamics simulation for automotive system.	08 Hours

Course outcomes:

After completion of above course, students will be able to

1. To explain different dynamics of Automotive system and basics behind the multi body dynamics**.**
2. Explain Rigid body and kinematic constraints
3. Generatemultibody codes, static and inverse dynamics
4. Do modal analysis by using MBD softwares.

Question paper pattern:

1. The question paper will have ten questions.

2. Each full question consists of 16 marks.
3. There will be 2full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text books:

1. Multibody Dynamics, Huston- R.L., Butterworth- Heinemann, (1990).
2. Dynamics of Multibody Systems- Shabana, A.A., Wiley, (1989).

Reference Books:

1. Computational Methods for Multibody Dynamics -Amirouche, F.M.L, Prentice-Hall, (1992).
2. Computer-Aided Kinematics and Dynamics of Mechanical Systems-Haug, E.J., Volume I: Basic Methods, Allyn and Bacon, (1989).
3. Dynamics of Multibody Systems - Roberson, R.E. and Schwertassek, R., Springer-Verlag, (1988).
4. Multibody System Handbook - Schiehlen, W.O., Springer- Verlag, (1990).
5. MSC ADAMS user Manual.

AUTOMOTIVE CHASSIS
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Subject Code	16 MAU252	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
Credits	03		

Course objectives: At the end of the course the student will be able to:

1. Select layout and components of automotive chassis.
2. Design frames automobiles
3. Explain construction, working and design of various chassis components.

Modules	Teaching Hours
Module-1	
Overview of Vehicle chassis System: General construction of chassis, Types of chassis layouts with respect to location of Power plant and drive arrangements and their comparison. Stability of vehicle on slope, weight distribution, numerical on above topics. **Frames:** Types of frames, loads acting of frame, cross sections and materials for frames, loading points, sub frames, calculation of cross section of frame members, Testing of frames.	08 Hours
Module -2	
Front axle and steering systems: Types of front axles and stub axles, Axle parts and materials, loads and stresses, center sections, section near steering head, spring pads, Front wheel geometry- Camber, Castor, toe –in, toe out, King Pin Inclination, under steer and over steer conditions, etc. Condition for correct steering, types of steering gears, power steering, Types of linkages, Ackermann and Davis steering mechanisms, Reversible and Irreversible steering.	08 Hours
Module -3	
Suspension system: Need, functions and requirements of suspension system, types of suspension system, Constructional details of leaf spring, helper springs, coil springs, torsion bar, rubber springs, plastic springs, air bellows or pneumatic suspension, hydraulic suspension, constructional details of telescopic shock absorbers, independent suspension, front wheel independent suspension, rear wheel independent suspension, types, stabilizer, trouble shooting, Numerical problems.	08 Hours
Module -4	
Brakes: Necessity and requirements of brakes, stopping distance and time, brake efficiency, weight transfer, brake shoe theory, determination of braking torque, Classification of brakes, constructional details- Drum Bakes Disc brakes and their comparison, Hydraulic brake system, Pneumatic brakes, Power assisted Braking system, Servo Brakes, Anti-lock Braking system, Retarders, Hill Holders, Requirements of brake fluids, , trouble shooting	08 Hours

Module -5	
Rear Axles: Construction of rear axles, Types of loads acting on rear axle, Full floating, Three Quarter Floating and Semi – floating axles, Hotchkiss and torque tube drive. **Wheels and Tyres:** Types of wheels, construction, structure and function, wheel dimensions, structure and function of tyres, static and dynamic properties of pneumatic tyres, types of tyres, materials, tyre section & designation, factors affecting tyre life, special wheels, trouble shooting.	08 Hours
Course outcomes: After completion of above course, students will be able to 1. Select layout and components of automotive chassis. 2. Design frames automobiles 3. Explain construction, working and design of various chassis components.	
Question paper pattern: 1. The question paper will have ten questions. 2. Each full question consists of 16 marks. 3. There will be 2 full questions (with a maximum of four sub questions) from each module. 4. Each full question will have sub questions covering all the topics under a module. 5. Use of Design data handbook is permitted in examination. 6. The students will have to answer 5 full questions, selecting one full question from each module.	
Text Books: 1. Automotive Chassis – P.M. Heldt, Chilton & Co. 2. Automotive Mechanics – N.K. Giri ,Khanna Publications, New Delhi,2004.	
Reference Books 1. Automotive mechanics – Joseph I Heintner, Affiliate d East West Press, New Delhi/Madras,1967 2. Automobile Engineering Vol. I - Kirpal Singh, Standard publications, New Delhi 3. A Text Book of Automobile Engineering- Laxmi Publications Private Ltd, 2007.	

MANUFACTURING TECHNIQUES IN AUTOMOTIVE ENGINEERING
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Subject Code	16MAU253	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
Credits	03		

Course objectives: At the end of the course the student will be able to:

1. Select sheet metal forming processes
2. Explain Forging process
3. Explain Powder Metallurgy Processes
4. Use different metal joining methods used in automobiles
5. Use plastic joining methods

Modules	Teaching Hours
Module-1	
Sheet Metal Forming: Introduction, Forming methods, shearing and Blanking, Bending, stretch forming, Deep drawing, redrawing operations, Defects in formed products. **High Energy Rate Forming:** Explosive forming, Electro-hydraulic forming, Electro-magnetic forming, Super Plastic Forming – Process principles, Equipment, Process variables, Merits and Limitations	08 Hours
Module -2	
Forging: Classification, various stages during forging, Forging equipment, brief description, deformation in compression, forging defects. Residual stresses in forging. **Special Casting processes:** Gravity die-casting, Pressure die casting, Centrifugal casting, Squeeze Casting, Slush casting, Thixo-casting and Continuous Casting Processes. Different casting techniques for manufacturing of automotive components like cylinder block, piston, flywheel, bearing liners, etc.	08 Hours
Module -3	
Powder Metallurgy Processing: Process details and special characteristics of Powder Metallurgy process, Powder making methods, Characteristics of Powders, Process flow chart, Process steps and Process variables. Compaction techniques like CIP & HIP (Cold Iso-static and Hot Iso-static pressing), Product design considerations, Applications of Powder metallurgy.	08 Hours
Module -4	
Joining methods- Fusion: MIG-CO2 welding, Flux Cored Arc Welding, Resistance Seam, Spot and Projection Welding-Process principles, Equipment, Process variables, Merits and Limitations. **Solid State Welding:** Friction Welding, Friction Stir Welding - Process principles, Equipment,	08 Hours

Process variables, Merits and Limitations.	
Module -5	
Joining of Plastics: Heated tool welding or hot bar welding, Hot gas welding or pendulum welding, High frequency welding, Ultrasonic welding, Friction welding, Induction welding.	08 Hours
Course outcomes: After completion of above course, students will be able to 1. Select sheet metal forming processes 2. Explain Forging process 3. Explain Powder Metallurgy Processes 4. Use different metal joining methods used in automobiles 5. Use plastic joining methods	
Question paper pattern: 1. The question paper will have ten questions. 2. Each full question consists of 16 marks. 3. There will be 2full questions (with a maximum of four sub questions) from each module. 4. Each full question will have sub questions covering all the topics under a module. 5. The students will have to answer 5 full questions, selecting one full question from each module.	
Text Books: 1. Fundamentals of Working of Metals- Sach G., Pergamon Press. 2. Engineering Materials & their applications, R. A. Flinn& P. K. Trojan, 4th edition, Jaico Publishing House.	
Reference Books: 1. ASM Handbook on Powder Metallurgy, Volume 17, ASM publications 2. High speed combustion engines- P.M. Heldt, Oxford and IBH Publishing Co, New York, 1990. 3. AWS Hand Book on welding 4. Welding Technology- O.P. Khanna. 5. Welding for Engineers-Udin, funk &Wulf. 6. Welding and Welding Technology- R.L. Little.	

SIMULATION OF I. C. ENGINE PROCESSES
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Subject Code	16MAU254	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
Credits	03		

Course objectives: At the end of the course the student will be able to:

1. Device various numeric techniques being used in the automotive system and sub system simulations.
2. Design and Evaluation of Simulation Experiments.
3. Simulate of SI and CI engines combustion process.

Modules	Teaching Hours
Module-1	
Principle Of Computer Modeling and Simulation: Monte Carlo simulation, Nature of computer modeling and simulation, advantages of simulation, limitations of simulation, and areas of application. **System and Environment:** Components of a system-iscrete and continuous systems. Models of a system-a variety of modeling approaches.	08 Hours
Module -2	
Design and Evaluation of Simulation Experiments: Variance reduction techniques-antithetic variables- variables verification and validation of simulation models.	08 Hours
Module -3	
S.I. Engine Simulation and Two Stroke Engine: Simulation of Otto cycle at full throttle, part throttle and supercharged conditions. Progressive combustion, Exhaust and intake process analysis. Two Stroke Engine Simulation-Engine and Porting Geometry, Gas Flow, Scavenging.	08 Hours
Module -4	
C.I. Engine Simulation: Simulation of ideal Diesel cycle and Diesel cycle at full throttle, part throttle and supercharged conditions. Zero dimensional combustion model, Progressive combustion, Exhaust and intake process analysis.	08 Hours
Module -5	
Simulation Exercises: Case studies of Simulation for 2 stoke and 4 stroke engine. Simulation exercises using computers – MATLAB/SimuLink, Pro-E / ICEM, CFD Analysis, FE Analysis procedures, Advantages of FEA, Simple Exercise using MSC Nastran. **Multi-body Simulation Exercises:** Simple Multi-body Suspension, Four Bar mechanisms, Handling Analysis of simple Bogie using MSC Adams.	08 Hours

Course outcomes:

After completion of above course, students will be able to

1. Device various numeric techniques being used in the automotive system and sub system

simulations.
2. Design and Evaluation of Simulation Experiments.
3. Simulate of SI and CI engines combustion process.

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text books:

1. Computer Simulation of Spark Ignition Engine Processes - V. Ganesan, Universities Press, 1995.
2. Computer Simulation of Compression Ignition Engine Processes - V. Ganesan, Universities Press, 1995.

Reference Books:

1. Combustion Modeling in Reciprocating Engines - J. N. Mattavi and C. A. Amann, Plenum Press, 1980.
2. The Thermodynamics and Gas Dynamics of Internal Combustion Engines, Vol. I & II - Horlock and Winterbone, Clarendon Press, 1986.
3. The Basic Design of two-stroke engines - Gordon P. Blair, SAE Publication, 1990.
4. Internal Combustion Engine Modeling - J. I. Ramos, Hemisphere Publishing Corporation, 1989
5. MSC Nastran / Adams User Manual
6. MATLAB User manual
7. System Simulation with digital Computer - NARSINGH DEO, prentice Hall Of India,1979.

AUTOMOTIVE ENGINEERING LAB – II [As per Choice Based Credit System (CBCS) scheme] SEMESTER – II			
Subject Code	16MAUL26	IA Marks	20
Number of Practical Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	39	Exam Hours	03
Credits	02		

Note:
1) These are independent laboratory exercises
2) A student may be given one or two problem
3) Student must submit a comprehensive report on the problem solved and give a Presentation on the same.
4) For Numerical Simulation, FEA software must be used such as MSC Patran/MSC Nastran and etc...
5) For Multi body Dynamics simulation , MSC Adams or equivalent software can be used

List of Experiments

1	Study of Suspension systems used in low, medium and Heavy vehicle
2	Simulation of Suspension system using commercial software for LCV and HCV
3	Study of Drive line systems and Simulation using Commercial MBD software
4	Stress Analysis of Chassis components using FE Software
5	Testing Two Wheeled Vehicles on Chassis Dynamometer
6	Study and practice of wheel alignment (computerized) and wheel balancing
7	Head light focusing test and visibility test
8	Simulation of Static and Dynamic head light bending
9	Study of MPFI and CRDI
10	Impact Analysis of Automotive Vehicle System using FE Software.

SEMINAR ON CURRENT TOPICS [As per Choice Based Credit System (CBCS) scheme] SEMESTER – II			
Subject Code	16MAU27	IA Marks	100
Number of Practical/ Field /assignments Hours/Week	03	Exam Marks	--
Credits	01	Exam Hours	--

Students should make presentation on current scenario/ latest technologies in Automotive Engineering

ALTERNATIVE FUELS AND POLLUTION CONTROL
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – IV

Subject Code	16MAU41	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
Credits	04		

Course objectives: At the end of the course the student will be able to:

1. Explain need for alternative fuels, various alternative fuels available and their suitability for automotive application.
2. Explain sources of pollution from automobiles and effects of pollutants on living beings.
3. Select suitable means for controlling pollution from automobiles
4. Select suitable method of sampling of pollutants
5. Explain various techniques adopted for reduction of Pollution from Automobile.

Modules	Teaching Hours
Module-1	
Introduction: Types of energy sources, their availability, need of alternative energy sources, Non-conventional energy sources, Classification of alternative fuels, Scenario of conventional auto fuels, fuel quality aspects related to emissions. Technological up gradation required, business driving factors for alternative fuels. Implementation barriersfor alternative fuels. **Gaseousalternativefuels&Bio-Diesel** **Hydrogen:** Introduction, properties and production of hydrogen. Storage, Advantages and disadvantages of hydrogen as fuel for S. I. and C. I. engines. Hazards and safety systems for hydrogen, hydrogen combustion. Performance and emission of from hydrogen. **Other gaseous fuels:** Properties, production, advantages and disadvantages of LPG, CNG, Methanol and Ethanol and their blends as Fuel for SI and CI engine.	10 Hours
Module -2	
Bio-Diesel: Straight vegetable oil, Biodiesel-Production of Bio-Diesel, Bio-Diesel as Fuel for CI engine, Performance and emission of bio diesel. **BiogasorBiomethane:** History, properties and production of Biogas, classification of biogas plants, biogas storage and dispensing system. Advantages of biogas, hazards and emissions of biogas. **Reformulatedconventionalfuels** Introduction. Production of coal water slurry. Properties, as an engine fuel, emissions of CWS. RFG, Emulsified fuels. Hydrogen-enriched gasoline. Future Alternative Fuels, PMF, Ammonia, Liquid-Nitrogen.	10 Hours
Module -3	
Emission from Automotive Engines: **Source of Emission from Automobiles:** Sources of Air Pollution. Various emissions from Automobiles – Formation-Effects of pollutants on environment and human beings.	10 Hours

S.I. Engine Emissions and its Control: Emission formation in SI Engines- Carbon monoxide & Carbon dioxide - Unburned hydrocarbon, NOx, Smoke-Effects of design and operating variables on emission formation- controlling of pollutants - Catalytic converters, Charcoal Canister, CCS, Positive Crank case ventilation system, Secondary air injection, thermal reactor, Laser Assisted Combustion, etc.	
Module -4	
C.I. Engine Emission and its Control: Formation of White, Blue, and Black Smoke, NOx, soot, sulphur particulate and Intermediate Compounds – Physical and Chemical delay — Significance Effect of operating variables on Emission formation- Fumigation, Split injection, Add Blue, Catalytic Coating, EGR, HCCI, Particulate Traps, SCR. **Influence of Fuel Properties on Emission and Effect of Air Pollution:** Effect of petrol, Diesel Fuel, Alternative Fuels and lubricants on emissions, Effect of air pollution on Human Health, Effect of air pollution on animals, Effect of air pollution on plants	10 Hours
Module -5	
Test Procedures and Emission Measurements: Constant Volume Sampling I and 3 (CVS-1&CVS-3) Systems, Sampling Procedures- Chassis dyno- Seven mode and thirteen mode cycles for Emission Sampling-Sampling problems-Emission analysers-NDIR, FID, Chemiluminesecent, Smoke meters.	10 Hours
Course outcomes: At the end of the course students will be able to 1. Explain need for alternative fuels, various alternative fuels available and their suitability for automotive application. 2. Explain sources of pollution from automobiles and effects of pollutants on living beings. 3. Select suitable means for controlling pollution from automobiles 4. Select suitable method of sampling of pollutants 5. Explain various techniques adopted for reduction of Pollution from Automobile.	
Question paper pattern: 1. The question paper will have ten questions. 2. Each full question consists of 16 marks. 3. There will be 2full questions (with a maximum of four sub questions) from each module. 4. Each full question will have sub questions covering all the topics under a module. 5. The students will have to answer 5 full questions, selecting one full question from each module.	
Textbooks: 1. Engine Emissions, Pollutant formation- G. P. Springer ad D. J. Patterson, Plenum Press, New York, 1986. 2. Alternative Fuels- S .S. Thipse. JAICO Publishing House. 3. Non-Conventional Energy Sources- G. D. RaiKhanna Publishing New Delhi	
Reference Books: 1. Internal combustion Engines- V. Ganesan, Tata McGraw Hill Book Co, Eighth Reprint, 2005. 2. Automotive Emission Control- Crouse and Anglin, McGraw Hill Company., New York 1993. 3. D. J. Patterson and N. A. Henin, 'Emission from Combustion Engine and their control', Anna Arbor Science Publication, 1985.	

VEHICLE PERFORMANCE
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – IV

Subject Code	16MAU421	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
Credits	03		

Course objectives: At the end of the course the student will be able to:

1. Explain various parameters affecting the performance of a vehicle.
2. Explain significance of Friction and rolling resistance of pneumatic tyres.
3. To study the performance of different Vehicle transmissions.
4. Analyze Handling characteristics and stability of vehicles.

Modules	Teaching Hours
Module-1	
Introduction to vehicle system: Morphology of vehicles, General layout of passenger cars and commercial vehicle, Type of power units, arrangement of power train, Vehicle controls.	08 Hours
Module -2	
Friction and rolling resistance of pneumatic tyres: Aerodynamics forces and moments, Relationship between tractive effort and longitudinal slip of tyres, cornering properties of tyres, Equation of motion and maximum tractive effort.	08 Hours
Module -3	
Vehicle performance estimation and prediction: Power plant characteristic and transmission related requirements, Vehicle acceleration, and max. Speed, Gradability Drive systems comparison.	08 Hours
Module -4	
Vehicle transmissions: Characteristics and features friction clutches, mechanical geared transmission lay shaft and epicyclic gearbox, Synchronizers, Fluid coupling and torque converters. Drive lines, two wheel drive, four wheel drive, braking arrangement, safety in braking, weight transfer steering, and cornering power of tyres.	08 Hours
Module -5	
Handling characteristics of vehicles: Steering geometry, steady state handling characteristics, steady state response to steering input. Directional stability of vehicle. Effect of shock and vibration on human being, comfort criteria.	08Hours

Course outcomes: After completion of above course, students will be able to

1. Explain various parameters affecting the performance of a vehicle.
2. Explain significance of Friction and rolling resistance of pneumatic tyres.
3. To study the performance of different Vehicle transmissions.
4. Analyze Handling characteristics and stability of vehicles.

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2full questions (with a maximum of four sub questions) from each module.

4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Textbooks:

1. Theory and Practice of Mechanical Vibrations- Rao J.S. and Gupta. K., Wiley Eastern Ltd., 2ndEdition,2002.
2. Theory of ground vehicle- J. Y. Wong, John Wiley and Sons Inc., New York,1stEdition, 1978.
3. Automobile Mechanics- Dr. N. K. Giri, Seventh reprint, Khanna Publishers, Delhi, 3rdEdition,2005

Reference Books:

1. Mechanics of road vehicle- W. Steeds, Illiffe Books Ltd, London3rdEdition, 1992.
2. Steering, Suspension tyres- J. G. Giles, Illife Books Lid London1st Edition, 1975.
3. Automotive chassis- P. M .Heldt, Chilton Co,New York, 1st Edition,1982.
4. Vehicle Dynamics- J. R. Ellis, Business Books, London, 2ndEdition,1969.

HYBRID VEHICLE TECHNOLOGIES
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – IV

Subject Code	16MAU422	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
Credits	03		

Course objectives: At the end of the course the student will be able to:

1. Explain need for hybrid vehicle, their layouts.
2. Differentiate types of DC motors, different types of AC motors, advantages & disadvantages of DC&AC motors used for propulsion.
3. Explain Grade and cruise targets, launching and boosting, braking and energy recuperation, drive cycle implication, engine fraction-engine downsizing and range, the concepts of matching electric drive and I. C. engine, sizing the propulsion motor.
4. Explain principles of batteries, different types of batteries, different types of fuel cell, and characteristics of fuel cell.
5. Explain Hydrogen storage system, super capacitors, ultra capacitors and flywheels.

Modules	**Teaching Hours**
Module-1	
Hybrid Vehicles: Introduction to HVs, Performance characteristics of road vehicles; calculation of road load, predicting fuel economy, grid -connected hybrids. **Hybrid architecture:** Series configuration- locomotive drives, series parallel switching, load tracking architecture. Pre transmission parallel and combined configurations-Mild hybrid, power assist, dual mode, power split, power split with shift, Continuously Variable transmission (CVT), wheel motors	08 Hours
Module -2	
Propulsion methods: DC motors-series wound, shunt wound, compound wound and separately excited motors AC motors-Induction, synchronous, brushless DC motor, switched reluctance motors.	08 Hours
Module -3	
Hybrid power plant specifications: Grade and cruise targets, launching and boosting, braking and energy recuperation, drive cycle implications, engine fraction-engine downsizing and range and performance, usage requirements. **Sizing the drive system:** Matching electric drive and ICE, sizing the propulsion motor; sizing power electronics.	08 Hours
Module -4	
Energy storage technology: Battery basics; lead-acid battery; different types of batteries; battery parameters, Battery Recycling **Fuel cells:** Fuel cell characteristics, fuel cell types – alkaline fuel cell, proton exchange Membrane; direct methanol fuel cell, phosphoric acid fuel	08 Hours

cell, molten carbonate fuel cell, solid oxide fuel cell, hydrogen storage systems, reformers, fuel cell EV, super and ultra capacitors	
Module -5	
Non-electric Hybrid Propulsion Systems: Short-Term Storage Systems- Flywheel Accumulators. Continuously Variable Transmissions Hydraulic Accumulators Hydraulic Pumps/Motors, Pneumatic Hybrid Engine Systems- Operation Modes.	08 Hours

Course outcomes:

After completion of above course, students will be able to

1. Explain need for hybrid vehicle, their layouts.
2. Differentiate types of DC motors, different types of AC motors, advantages & disadvantages of DC&AC motors used for propulsion.
3. Explain Grade and cruise targets, launching and boosting, braking and energy recuperation, drive cycle implication, engine fraction-engine downsizing and range, the concepts of matching electric drive and ic engine, sizing the propulsion motor.
4. Explain principles of batteries, different types of batteries, different types of fuel cell, and characteristics of fuel cell.
5. Explain Hydrogen storage system, super capacitors, ultra capacitors and flywheels.

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. The Electric Car: Development & Future of Battery, Hybrid & Fuel-Cell Cars - Mike Westbrook, M H Westbrook, British library Cataloguing in Publication Data.
2. Electric and Hybrid Vehicles- Robin Hardy, Iqbal Husain, CRC Press.
3. Propulsion Systems for Hybrid Vehicles- John M. Miller, Institute of Electrical Engineers, London.

Reference Books:

1. Energy Technology Analysis Prospects for Hydrogen and Fuel Cells, International Energy Agency, France.
2. Handbook of Electric Motors- Hamid A Toliyat, Gerald B Kliman, Marcel Decker Inc.

OFF ROAD VEHICLES
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – IV

Subject Code	16MAU423	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
Credits	03		

Course objectives: At the end of the course the student will be able to

1. Explain working and applications of earth moving equipment.
2. Select suitable under carriage, hydraulics, steering systems for off road vehicles.
3. Select suitable machine depending on type of land, haul distance, climate, etc.
4. Formulate maintenance schedule for off road vehicles

Modules	Teaching Hours
Module-1	
Equipment and operation: Different types, capacity, working principles and applications of bull Dozers, Loaders, Shovels, Excavators, Scrapers, Motor graders, Rollers, Compactors, Tractors and Attachments.	08 Hours
Module -2	
Engine, under carriage and Suspension systems: All systems of engine and special features like Automatic injection timer, turbochargers, after coolers etc., tyre and tracked vehicles, advantages and disadvantages under carriage components like, tracks, roller frames, drive sprockets, track rollers, track chains and track shoes. Rubber spring suspension and air spring suspension.	08 Hours
Module -3	
Transmissions and Final drives: Basic types of transmissions, auxiliary transmission, compound transmission, twin triple countershaft, transmissions and planetary, transmission, constructional and working principles, hydro shift automatic Transmission and retarders. FINAL DRIVES: types of reductions like, single reduction, double reduction final drives and planetary final drives PTO shaft.	08 Hours
Module -4	
Hydraulics: Basic components of hydraulic systems like pumps (types of pumps), control valves like flow control valves, directional control valves and pressure control valves, hydraulic motors and hydraulic cylinders, depth & draft control systems.	08Hours
Module -5	
Criterions for selection of equipment: Selection of machines based on type of soil, haul distance, weather condition, calculation of operating Capacity and calculation of productivity of a bull dozer. **Earth Moving Equipment Maintenance & Safety:** Types of maintenance schedules, purpose and advantages, organization set ups, documentation. Safety methods for earth moving equipment.	08 Hours

Course outcomes: After completion of above course, students will be able to

1. Explain working and applications of earth moving equipment.
2. Select suitable under carriage, hydraulics, steering systems for off road vehicles.
3. Select suitable machine depending on type of land, haul distance, climate, etc.
4. Formulate maintenance schedule for off road vehicles

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2 full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Diesel equipment- volume I and II by Erich J.schulz
2. Construction equipment and its management - S. C. Sharma

Reference Books:

1. Farm machinery and mechanism - Donald R. hunt and L. W. Garner
2. Theory of ground vehicles - J. Y. Wong john Wiley and sons
3. Moving the earth - Herbert Nicholas
4. On and with the earth - Jagman Singh, W. Newman and Co. Kalkata

TWO AND THREE WHEELER TECHNOLOGY
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – IV

Subject Code	16MAU424	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
Credit	03		

Course objectives: At the end of the course the student will be able to:

1. Describe construction and working of different type of internal combustion engines for two and three wheeled vehicles.
2. Laydown wiring diagram for two wheeler and three wheeled vehicles.
3. Explain types of clutches, transmission and final drives used for two and three wheeled vehicles.
4. Describe types of frames, stresses inducted in frames, brakes and tyres used for two and three wheeled vehicles.
5. Laydown maintenance schedule for two and three wheeled vehicles.

Modules	Teaching Hours
Module-1	
The Power Unit: Types of engines for two wheelers, advantages and disadvantages of two stroke and four stroke engines, engine components, constructional details, materials, symmetrical and unsymmetrical port timing diagrams, valve actuating mechanisms, valve timing diagrams. Rotary valve engine, Advantages and disadvantages of diesel engines for two wheelers, power plant for electric bikes, exhaust systems.	08 Hours
Module-2	
Fuel, Lubrication and Cooling system: Layout of fuel supply system, fuel tank construction, carburetor types, construction, working and adjustments. Types of cooling systems, advantages of air cooling system. Lubrication types, Lubrication of parts, grades of lubricating oils. **Electrical system:** Types of ignition system, their working principles, wiring diagram for Indian vehicles, spark plug construction, indicators and gauges used in two wheelers, lighting systems.	08 Hours
Module-3	
Transmission system: **Primary drive and Clutch:** Motor cycle power train, Primary drives, Types of primary drives, Chain drive, Gear drive, Construction and operation of motorcycle clutches, Clutch release mechanism. Gear boxes. **Transmission:** Introduction to motorcycle transmission, Sprockets and chain, Gears and Dogs in motor cycle transmission, Gear and Gear ratios, Sliding gear transmissions, Shifting fork mechanisms, Constant mesh transmissionsand lubrication. **Final drive:** Introduction to motorcycle final drives, Fundamentals of chain drive, Chain	08Hours

lubrication and lubricators, Shaft drives, Drive shaft couplings, Final drive gear case.	
Module -4	
Frames and suspension: Types and constructional details of frames, advantages and limitations, frame materials, frame stresses, frame building problems, frame components, Front and Rear suspension systems, shock absorber construction and working, Panel meters and controls on handle bar, body manufacture and painting. **Brakes and Wheels:** Front and rear braking systems, disc and drum brakes, merits and demerits, Types of wheels, loads on wheels, construction and materials for wheels, wheels designation, tyre designation, inflation, types of tyres, construction details.	08 Hours
Module -5	
Two wheelers and Three wheelers: Case study of major Indian models of major motor cycles, scooters, scooteretts and mopeds. Case study of Indian models of three wheelers, Front mounted engine and rear mounted engine types, Auto rickshaws, pick up van, delivery van and trailer. **Maintenance:** Importance of maintenance, Decarburizing procedure for engine and silencer, periodic inspection, maintenance schedules, trouble diagnosis charts, safety precautions, Lubrication charts.	08Hours

Course outcomes: After completion of above course, students will be able to

1. Describe construction and working of different type of internal combustion engines for two and three wheeled vehicles.
2. Laydown wiring diagram for two wheeler and three wheeled vehicles.
3. Explain types of clutches, transmission and final drives used for two and three wheeled vehicles.
4. Describe types of frames, brakes and tyres used for two and three wheeled vehicles.
5. Laydown maintenance schedule for two and three wheeled vehicles.

Question paper pattern:

1. The question paper will have ten questions.
2. Each full question consists of 16 marks.
3. There will be 2 full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Motor cycle engines - P. E. Irving, Temple Press Book, London, 1992
2. Motor cycles -Michel M. Griffin
3. Motor cycle Mechanics - William H. Crouse and Donald L. Anglin, TMH

Reference Books:

1. The cycle Motor manual - Temple Press Ltd, 1990
2. Vespa maintenance and repair series - Bryaut R. V.
3. 3. Encyclopedia of Motor Cycling 20 volumes - Marshall Cavendish, New York., 1989