MANIPAL UNIVERSITY JAIPUR

DEPARTMENT OF AUTOMOBILE ENGINEERING

PROGRAMME STRUCTURE

B Tech Degree Program Automobile Engineering (2019-23)

THIRD SEMESTER												
						Exam duration (Hrs.)		Relative weightage				
Course Code	**Subject**	**L**	**T**	**P**	**C**	**Theory**	**Practical**	**CWS**	**MTE**	**PRS**	**PRE**	**ETE**
BB0025	Value Ethics & Governance	2	0	0	2	3		30	30			40
MA21O2	Engineering Mathematics-III	3	0	0	3	3		30	30			40
AU2101	Material Science and Metallurgy	3	0	0	3	3		30	30			40
AU2102	Strength of Materials	3	1	0	4	3		30	30			40
AU2103	Theory of Automotive Engines	3	1	0	4	3		30	30			40
AU2104	Engineering Thermodynamics	3	1	0	4	3		30	30			40
AU2130	Automotive Engines Lab	0	0	2	1		2			60	40	
AU2131	Strength of Materials Lab	0	0	2	1		2			60	40	
AU2170	Seminar	0	0	2	1		2			60	40	
	Total	**17**	**3**	**6**	**23**							

FOURTH SEMESTER												
						Exam duration (Hrs.)			Relative weightage			
Course Code	**Subject**	**L**	**T**	**P**	**C**	**Theory**	**Practical**	**CWS**	**MTE**	**PRS**	**PRE**	**ETE**
EO2001	Economics	3	0	0	3	3		30	30			40
MA2203	Engineering Mathematics-IV	3	0	0	3	3		30	30			40
AU2201	Automotive Chassis System	3	0	2	4	3	2	10	30	15	5	40
AU2202	Kinematics and Dynamics of Automobile	3	1	0	4	3		30	30			40
AU2203	Fluid Mechanics	3	0	0	3	3		30	30			40
*******	Open elective I	3	0	0	3	3		30	30			40
AU2230	Computer Aided Drawing Lab	0	0	4	2		2			60	40	
AU2231	Fluid Mechanics Lab	0	0	2	1		2			60	40	
AU2270	Project Based Learning I	0	0	2	1		2			60	40	
	Total	**18**	**1**	**10**	**24**							

FIFTH SEMESTER

						Exam duration (Hrs.)		Relative weightage				
Course Code	**Subject**	**L**	**T**	**P**	**C**	**Theory**	**Practical**	**CWS**	**MTE**	**PRS**	**PRE**	**ETE**
BB0026	Management	3	0	0	3	3		30	30			40
AU3101	Automotive Transmission Systems	3	0	2	4	3	2	10	30	15	5	40
AU3102	Manufacturing Technology	3	0	2	4	3	2	10	30	15	5	40
AU3103	Automotive Design	3	0	0	3	3		30	30			40
AU3104	Automotive Electrical and Electronic Systems	3	1	0	4	3		30	30			40
*******	Open elective II	3	0	0	3	3		30	30			40
AU3130	Automotive Design Lab	0	0	2	1		2			60	40	
AU3131	Automotive Electrical and Electronic Systems Lab	0	0	2	1		2			60	40	
AU3170	Project Based Learning II	0	0	2	1		2			60	40	
	Total	**18**	**1**	**10**	**24**							

SIXTH SEMESTER

						Exam duration (Hrs.)		Relative weightage				
Course Code	**Subject**	**L**	**T**	**P**	**C**	**Theory**	**Practical**	**CWS**	**MTE**	**PRS**	**PRE**	**ETE**
AU3201	Heat transfer	3	1	0	4	3		30	30			40
AU3202	Electric and Hybrid vehicle	3	0	0	3	3		30	30			40
AU3203	Quality Assurance and Reliability Engineering	3	1	0	4	3		30	30			40
AU32XX	Program Elective I	2	0	2	3	3	2	10	30	15	5	40
AU32XX	Program Elective II	2	0	2	3	3	2	10	30	15	5	40
*******	Open elective III	3	0	0	3	3		30	30			40
AU3230	Computer Integrated Manufacturing Lab	0	0	2	1		2			60	40	
AU3231	Vehicle Dynamics Simulation Lab	0	0	2	1		2			60	40	
AU3232	Automotive Control Systems Lab	0	0	2	1		2			60	40	
AU3270	Project Based Learning III	0	0	2	1		2			60	40	
	Total	**16**	**2**	**12**	**24**							

SEVENTH SEMESTER

						Exam duration (Hrs.)		Relative weightage				
Course Code	**Subject**	**L**	**T**	**P**	**C**	**Theory**	**Practical**	**CWS**	**MTE**	**PRS**	**PRE**	**ETE**
AU41XX	Program Elective III	2	0	2	3	3	2	10	30	15	5	40
AU41XX	Program Elective IV	2	0	2	3	3	2	10	30	15	5	40
AU41XX	Program Elective V	2	0	2	3	3	2	10	30	15	5	40
AU41XX	Program Elective VI	2	0	2	3	3	2	10	30	15	5	40
AU41XX	Program Elective VII	2	0	2	3	3	2	10	30	15	5	40
AU4170	Minor Project using Lean Six Sigma	0	0	4	2		2			60	40	
AU4171	Industrial training	0	0	2	1		2					100
	Total	**10**	**0**	**16**	**18**							

EIGHTH SEMESTER

						Exam duration (Hrs.)		Relative weightage				
Course Code	**Subject**	**L**	**T**	**P**	**C**	**Theory**	**Practical**	**CWS**	**MTE**	**PRS**	**PRE**	**ETE**
AU4270	Major Project	0	0	0	12			30	30			40
	Total	**0**	**0**	**0**	**12**							

List of Program Electives	
Course Code	**Course Name**
AU3240	Advanced Internal Combustion Engines
AU3241	Vehicle Body Engineering
AU3242	Computer Integrated Manufacturing and Robotics
AU3243	Artificial Intelligence
AU3244	Computer Aided Design & FEA
AU3245	Two and three wheeled vehicle Systems
AU3246	Automotive Materials and Manufacturing
AU3247	Data Analytics
AU4140	Product Design and Development
AU4141	Automotive Air Conditioning Systems
AU4142	Metrology and Measurement System Analysis (MSA)
AU4143	Automotive Noise, Vibrations & Harshness
AU4144	Earth Moving Equipment
AU4145	Optimization Techniques
AU4146	Vehicle Ergonomics and Safety Systems
AU4147	Autotronics and Autonomous Vehicle
AU4148	Production and Operations Management
AU4149	Computational Fluid Dynamics
AU4150	Automotive Service Operation
AU4151	Statistical Process Control and Statistical Quality Control
AU4152	Machine Learning
AU4153	Alternative fuels and energy systems
AU4154	Automotive pollution and control
AU4155	Vehicle Fault Diagnosis and Trouble Shooting
AU4156	Automatic Control System
List of Open Electives	
AU2080	Fundamentals of Automobile Engineering
AU2081	Fundamentals of Electric and Hybrid Vehicle
AU2082	Lean Six Sigma Problem Solving
AU2083	Trends in Vehicle Styling and Ergonomics
AU3080	Engine Emissions and Control
AU3081	Automotive Materials and Manufacturing Processes
AU3082	Autotronics
AU3083	Process Control and Reliability Engineering
AU3080	Vehicle Maintenance and Garage Practice
AU3081	Automotive Safety Systems
AU3082	Total Quality Management
AU3083	Product development

Course Content

BTECH AUTOMOBILE ENGINEERING (2019-23 BATCH)

THIRD SEMESTER

BB 0025: VALUE, ETHICS & GOVERNANCE [2 0 0 2]

Relevance of Value Education in day-to-day life. Mantra for success - Value, Moral and Ethics. Determinants of human nature (Three Gunas) and its impact on human life. Relevance of Personality, Attitude, Behavior, Ego, Character, introspection, Motivation, Leadership and 4 Qs with relevant Case Studies*.Governance: Understanding of Public and Private sector Governance systems; Courts & CAG. Public Sector Governance: Need, relevance, stakeholders. Private Sector Governance: Proprietary, Partnership, Company (Pvt Ltd & Ltd), Company' Act 2013, Board of Directors; its Roles and Responsivities. Regulatory bodies; its role in ethical governance. Projects on PPP mode-relevance & prospects.CSR: Relationship with Society, Philanthropy and Business strategy, CSR Policy, Triple Bottom Line. Suggestive Case Studies:Uphar Theatre Tragedy- Engineering Ethics, Bhopal Gas Tragedy- Operational Engineering Ethics, Satyam Case- Financial Reporting Ethics, Enron Case- Business Ethics, Navin Modi Case- Financial Fraudulence.

References:

1. Professional Module of ICSI.
2. Ghosh B.N., *Business Ethics & Corporate Governance*, (1e) McGraw Hill, 2011.
3. Mandal S.K., *Ethics in Business & Corporate Governance*, (2e), McGraw Hill, 2012.
4. Ray C.K., *Corporate Governance, Value & Ethics*, Vaya Education of India, 2012.
5. Chatterjee Abha, *Professional Ethics*, (2e) Oxford Publications.

MA2102: ENGINEERING MATHEMATICS - III [2 1 0 3]

Gradient, divergence and curl, Line, surface and volume integrals. Green's, divergence and Stoke's theorems. Fourier series of periodic functions. Half range expansions. Harmonic analysis. Fourier integrals. Sine and cosine integrals, Fourier transform, Sine and cosine transforms. Partial differential equation-Basic concepts, solutions of equations involving derivatives with respect to one variable only. Solutions by indicated transformations and separation of variables. One dimensional wave equation, one dimensional heat equation and their solutions. Numerical solutions of boundary valued problems, Laplace and Poisson equations and heat and wave equations by explicit methods.

References:

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 7(e), John Wiley & Sons, Inc., 2015.
2. S.S. Sastry, *Introductory methods for Numerical Analysis*, (5e), PHI Learning Private Limited, 2012.
3. B.S. Grewal, *Higher Engineering Mathematics*, 43(e), Khanna Publishers, 2014.
4. R. Spiegel Murray, *Vector Analysis*, Schaum Publishing Co., 1959.

AU2101: MATERIAL SCIENCE AND METALLURGY [3 0 0 3]

Introduction: Materials classification, Crystallography. Miller indices: Miller Bravais indices, Crystal structure determination. Imperfections in Crystals: Point defects, Line defects, Surface defects, Plastic Deformation, Metals and Alloys, Dislocation, Slip and twinning, Schmid's law. Strengthening mechanisms: Solid solution strengthening, Work hardening, Recovery recrystallization and grain growth. Diffusion: Steady state and non-steady state diffusion. Solidification of Metals and Alloys: Solid solution, Hume-Rothery rules, Phase diagrams Phase and Lever Rules relationship of micro Structure and properties, Isomorphs systems, Eutectic system, Eutectoid Peritectoid reactions, Iron- Carbon equilibrium diagram, Development of microstructure in Iron Carbon alloys, Phase transformation in steel, Heat Treatment ,TTT diagram. Steel: Low, medium, and high carbon steels, Stainless steels-ferrite, Austenitic, Martensitic, Duplex steels, Tool steels, Aluminium and its alloys, Magnesium and alloys, Titanium and its alloys. Other materials: Super alloys, ceramics, Refractories, Composites and glasses, Nano-materials.

References:

1. R Balasubramaniam, *Callister's Materials Science and Engineering*, (2e), Wiley India, 2010.
2. R Abbaschian, E Robert, *Physical Metallurgy Principles*, (4e), Cengage Learning, 2009.
3. V Raghavan, *Material science and engineering*, (6e), Prentice Hall India, 2015.
4. J F Shackelford, *Introduction to Materials science for Engineers*, (8e), Pearson, 2014.
5. A Sidney, *Introduction to physical metallurgy*, (2e), Tata McGraw Hill, 2017.

AU2102: STRENGTH OF MATERIALS [3 1 0 4]

Stresses and Strains: Overview of simple stresses and strains, Principal stresses and strains, Mohr's circle. Shear Force and Bending Moment: Bending moment and shear force diagrams for different types of static loading and support conditions on beams. Strain Energy:

Strain energy stored in the member due to various types of loading. Pure bending and Shear stress in beam: Theory of simple bending, bending stresses, section modulus and transverse shear stress distribution in circular, hollow circular, I, Box, T, angle sections etc. Torsion: Torsion of circular shafts – solid and hollow, stresses in shaft when transmitting power, shafts in series and parallel. Column and strut: Buckling load, Types of end conditions for column, Euler's column theory and its limitations, Rankine formula and other empirical relations. Deflection of Beam: Deflection of beam for different types of loadings. Thick and Thin cylindrical shells and spherical shells.

References:

1. S Timoshenko, *Strength of materials*, Vols. I (3e), CBS publications, 2014.
2. A Pytel, F L Singer, *Strength of Materials*, (4e), Harper & Collons, 2011.
3. F P Beer, E R Johnston, *Vector for Mechanics of Engineers*, (9e), Tata McGraw Hill, 2010.
4. S S Ratan, *Strength of Materials*, (3e), Tata McGraw-Hill, 2016.

AU2103: THEORY OF AUTOMOTIVE ENGINES [3 1 0 4]

Engine classifications, 4 stroke engine - Constructional details, working principle. Cylinder layout and configurations. Firing order and its significance. Engine balancing. Fuel feed system of gasoline and diesel engines Carburettor – requirements, working principle, types, different circuits – Compensation & Maximum power devices – Petrol injection in SI engines, FIP'S, CRDI, Magneto coil and battery coil spark ignition system. Electronic ignition System – CDI. Need for cooling. Types of cooling system – air cooling and Liquid cooled systems. Forced circulation system, pressure cooling system, Evaporative cooling system – Need for Lubrication system. Mist lubrication system, wet & dry sump lubrication. Two stroke engine – types, terminologies, definitions, construction and operation. Comparison of four stroke and two stroke engine operation. Theoretical scavenging processes. Merits and demerits, scavenging efficiency, Scavenging pumps, Supercharging and turbocharging, Combustion in SI & CI Engines – Introduction, Pressure Crank angle diagrams, Factors affecting combustion, Knocking in SI & CI Engines, Special type of engines like wankel, free piston, lean burn, Stratified charged & HCCI Engines

References:

1. J B Heywood, *Internal Combustion Engine Fundamentals*, (India Edition), McGraw Hill Publishers, 2011.
2. V Ganesan, *Internal Combustion Engines*, (4e), McGraw Hill, 2011.
3. K K Ramalingam, *Internal Combustion Engines*, (3e), Scitech Publishers, 2017.

AU2104: ENGINEERING THERMODYNAMICS [3 1 0 4]

Basic Concepts: Systems, Control Volume, Surrounding, Universe, Macroscopic and microscopic viewpoints, Concept of continuum, Thermodynamic equilibrium, State, Properties, Processes, Cycle, Reversibility, Causes of irreversibility, Energy in state and in transition, Work and heat, Point and path function. Laws of Thermodynamics: Zeroth Law of Thermodynamics, First Law of Thermodynamics for flow and non-flow processes, Second Law of Thermodynamics, Elementary Treatment of the Third Law of Thermodynamics. Entropy: Pure Substances, P-V-T- surfaces, T-S and h-s diagrams, Mollier Charts, Phase Transformations – Triple point at critical state properties during change of phase. Refrigeration Cycles: Brayton and Rankine cycles – Performance evaluation, combined cycles, Bell Coleman cycle, Vapour compression cycle, Performance evaluation.

References:

1. C Borgnakke, R E Sonntag, *Fundamentals of Thermodynamics*, (7e), John Wiley Pub, 2009.
2. Y Cengel, Boles, *Thermodynamics – An Engineering Approach*, (7e), TMH, 2000.
3. P k Nag, *Engineering Thermodynamics*, (6e), Tata McGraw Hill, 2017.

AU2130: AUTOMOTIVE ENGINES LAB [0 0 2 1]

Study of Special engine tools, equipment and safety, Assembling and Dismantling of single cylinder, multi cylinder engines, 2 stroke engine, valve & port timing. Performance testing on single cylinder, multi cylinder petrol & diesel engines, heat balancing, VCR engine performance test, FIP calibration test Engine tuning and overhauling.

References:

1. J B Heywood, *Internal Combustion Engine Fundamentals*, (India Edition), McGraw Hill Publishers, 2011.
2. V Ganesan, *Internal Combustion Engines*, (4e), McGraw Hill, 2011.

AU2131: STRENGTH OF MATERIALS LAB [0 0 2 1]

Introduction-Tensile test using UTM, load displacement and Stress Strain curves, Torsion Test, Compression Test, Bending Test, Impact test: Izode and Charpy Test, Hardness Test: Brinell and Rockwell test, Fatigue and Shear Test, Test on Helical Spring.

References:

1. E P Popov, *Engineering Mechanics of Solids*, PHI, 2004.
2. N E. Dowling, *Mechanical Behaviour of Materials*, Pearson Education, 2010.

AU2170: SEMINAR [0 0 2 1]

Each student has to present a seminar on any technical topic. The presentation time is a minimum of 30 minutes followed by a 10 minutes session for discussion/ question & answers; The seminar topic selected by the student must be approved by the authorized faculty of the department at least two weeks in advance; Each student has to submit a seminar report to the department at least three days before the day of seminar; Each student has to make the power point presentation (PPT).

FOURTH SEMESTER

EO2001: ECONOMICS [3 0 0 3]

Introduction: Definition, nature and scope of economics, introduction to micro and macroeconomics; Microeconomics: Consumer behaviour, cardinal and ordinal approaches of utility, law of diminishing marginal utility, theory of demand and supply, law of demand, exceptions to the law of demand, change in demand and change in quantity demanded, elasticity of demand and supply, Indifference curve, properties, consumer equilibrium, Price and income effect; Production: Law of production, production function, SR and LR production function, law of returns, Isoquant curve, characteristics, Isocost, producer's equilibrium; Cost and revenue analysis: Cost concepts, short run and long- run cost curves, TR, AR, MR; Various market situations: Characteristics and types, Break-even analysis; Macro Economics: National Income, Monetary and Fiscal Policies, Inflation, demand and supply of money, consumption function and business cycle.

References:

1. H.L Ahuja, *Macroeconomics Theory and Policy*, (20e), S. Chand Publication.
2. H.C. Peterson, *Managerial Economics*, (9e), 2012.
3. P.L. Mehta, *Managerial Economics*, Sultan Chand & Sons.
4. G.J. Tuesen, H.G. Tuesen, *Engineering Economics*, PHI.
5. J.L. Riggs, D.D. Bedworth, Sabah U Randhawa, *Engineering Economics*, Tata McGraw Hill.

MA2203: ENGINEERING MATHEMATICS – IV [2 1 0 3]

Statistics: Measures of central tendency, measures of dispersion, Correlation coefficient, regression, least squares principles of curve fitting. Probability: finite sample spaces, conditional probability and independence, Baye's theorem, one-dimensional random variable, mean, variance. Two and higher dimensional random variables: mean, variance, correlation coefficient. Distributions: Binomial, Poisson, uniform, normal, gamma, Chi-square and exponential distributions, simple problems. Moment generating function, Functions of one dimensional and two-dimensional random variables, Sampling theory, Central limit theorem and applications. Optimization: Basic concepts, Linear programming, Graphical and Simplex methods, penalty cost and two-phase methods. Transportation problems.

References:

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 7(e), John Wiley & Sons, Inc., 2015.
2. P. L. Meyer, *Introduction to Probability and Statistical Applications*, (2e), Oxford and IBH Publishing, Delhi, 1980.
3. B.S. Grewal, *Higher Engineering Mathematics*, 43(e), Khanna Publishers, 2014.
4. A Taha Hamdy*, Operation research*, (7e), Inc. Pearson Education, 2014.

AU2201: AUTOMOTIVE CHASSIS SYSTEM [3 0 2 4]

Automotive chassis and frames, functions, requirements, classification. New techniques in chassis design, Braking systems: requirements, principle of operation, classification, different types of vehicle brakes, and mechanics of brakes. Steering systems: condition for true steering, steering linkages, and power steering. Suspension systems: classification, functions, rigid and independent suspension systems. Automotive wheels and tyres.

Lab: Dismantling and assembling of different types of braking systems, steering systems and suspension systems. Wheel balancing and alignment.

References:

1. K Newton, W Steeds, T K Garrett, *The Motor Vehicle*, SAE Publications, 2004.
2. J I Heintner, *Automotive mechanics principles and practice*, CBS Publishers and distributors, 2004.
3. T R Banga, N Singh, *Automobile Engineering*, Khanna Publishers, 2007.
4. R K Rajput,, *Automobile Engineering*, Laxmi Publications Ltd, 2008.

AU2202: KINEMATICS AND DYNAMICS OF AUTOMOBILE [3 1 0 4]

Mechanism and inversions. Degrees of freedom. Mathematical analysis of velocity and accelerations of simple mechanisms. Synthesis of cams and gears. Gear trains. Static and dynamic force analysis of linkages. Balancing of rotating and reciprocating masses. Governors and its characteristics. Gyroscope and gyroscopic effect on automobiles, Hooks joint.

References:

1. J J Uicker, G R Pennock, J E Shigley, *Theory of Machines and Mechanisms*, Oxford University Press, 2011.
2. A Gosh, A K Malik, *Theory of Mechanisms and Machines*, East West Publishers, 2006.
3. J S Rao, R V Dukkipati, *Mechanisms and Machines Theory*, New Age Int.., 2007.
4. S S Rattan, *Theory of Machines*, Tata Mc Graw Hill, 2008.

AU2203: FLUID MECHANICS [3 0 0 3]

Fundamentals: Definition and properties of fluids, intensity of pressure, variation of pressure in a static fluid, Manometers. Fluid statics: Hydro static forces and centre of pressure on plane surfaces, Buoyancy, centre of Buoyancy, Meta-centre and Meta-centric height, Stability of floating and sub-merged bodies. Kinematics and Dynamics of fluid flow: Types of fluid flow, continuity equation, one dimensional Euler's equation of motion, Bernoulli's energy equation. Fluid flow measurements: Pitot tube, orifice meter, venture meter and notch. Viscous flow: Reynolds Number, laminar flow through circular pipe, laminar flow between fixed parallel plates. Fluid flow in pipes: Losses in pipes, Minor and major losses, Darcy and Chezy equations. Dimensional analysis and Similitude: Methods of dimensional analysis, similitude. Pneumatic & Hydraulic valves: Construction and working of various types of direction control, pressure control, flow control valves, servo valve, proportional valve, accumulator. Hydraulic & Pneumatic circuits: Regeneration, meter in, meter out, bleed off, sequencing, counter balancing, pressure reducing and typical application circuits.

References:

1. Y Cengel, J M Cimbala, *Fluid Mechanics*, Tata Mcgraw-Hill Publications, New Delhi, 2013.
2. F N White, *Fluid Mechanics*, Tata Mcgraw-Hill Publications, New Delhi, 2011.
3. B R Munson, T H Okiishi, W W Huebsch, A P Rothmayer, *Fundamentals of Fluid Mechanics*, John Wiley and Sons, New Jersey, 2013.
4. C T Crowe, D F Elger, B C Williams, J A Roberson, *Engineering Fluid Mechanics*, John Wiley and Sons, New Jersey, 2009.

AU2230: COMPUTER AIDED DRAWING LAB [0 0 4 2]

Introduction: CAD software and its applications. Software: Auto CAD and Creo. GD & T: Introduction to GD & T, part features, symbols, screw threads, gears and splines, basic dimension, limits, fits & tolerances, Datum and plane. 2D Part Drawing using Auto – CAD. 3D Part modelling using Creo – exercises on modelling of automotive components.

Reference:

1. A Krulikowski, *Fundamentals of Geometric Dimensioning and Tolerancing*, International edition, Delmar Cengage Learning, 2012.
2. G Omura, B C Benton, *Mastering AutoCAD 2013*, serious skill, 2012.

AU2231: FLUID MECHANICS LAB [0 0 2 1]

Flow Measuring Devices, Pneumatic and Hydraulic actuators: Linear Actuator- single acting & double acting cylinder, rotary actuator-gear, vane and piston pump. Pneumatic and Hydraulic valves: direction control, pressure control and flow control valves, servo valves, proportional valves. Hydraulic trainer, Pneumatic trainer.

References:

1. A Esposito, *Fluid Power with Applications*, (7e), Prentice-Hall International, 2008.
2. I Sivaraman, *Introduction to Hydraulics and Pneumatics*, (3e), PHI Learning Pvt. Ltd., 2017.
3. Y Cengel, J Cimbala, *Fluid Mechanics,* (3e), McGraw Hill Education, 2017.

AU2270: PROJECT BASED LEARNING I [0 0 2 1]

Project-based learning involves students designing, developing, and constructing hands-on solutions to a problem. The educational value of Project based learning is that it aims to build students' creative capacity to work through difficult or ill-structured problems, commonly in small teams. Typically, Project based learning takes students through the following phases or steps: Identifying a problem, Agreeing on or devising a solution and potential solution path to the problem (i.e., how to achieve the solution), Designing and developing a prototype of the solution, refining the solution based on feedback from experts, instructors, and/or peers. Depending on the goals of the instructor, the size and scope of the project can vary greatly.

FIFTH SEMESTER

BB0026: ORGANISATION AND MANAGEMENT [3 0 0 3]

Meaning and definition of an organization, Necessity of Organization, Principles of Organization, Formal and Informal Organizations. Management: Functions of Management, Levels of Management, Managerial Skills, Importance of Management, Models of Management, Scientific Management, Forms of Ownership, Organizational Structures, Purchasing and Marketing Management, Functions of

Purchasing Department, Methods of Purchasing, Marketing, Functions of Marketing, Advertising. Introduction, Functions of Personal Management, Development of Personal Policy, Manpower Planning, Recruitment and Selection of manpower. Motivation – Introduction, Human needs, Maslow's Hierarchy of needs, Types of Motivation, Techniques of Motivation, Motivation Theories, McGregor's Theory, Herzberg's Hygiene Maintenance Theory. Leadership - Introduction Qualities of a good Leader, Leadership Styles, Leadership Approach, Leadership Theories. Entrepreneurship-Introduction, Entrepreneurship Development, Entrepreneurial Characteristics, Need for Promotion of Entrepreneurship, Steps for establishing small scale unit. Data and Information; Need, function and Importance of MIS; Evolution of MIS; Organizational Structure and MIS, Computers and MIS, Classification of Information Systems, Information Support for functional areas of management.

Reference:

1. Koontz, Harold, Cyril O'Donnell, and Heinz Weihrich, *Essentials of Management*,(1e) Tata McGraw-Hill, New Delhi, 1978.
2. Robbins, Stephen P, and Mary Coulter, *Management, Prentice Hall*, (2e) New Delhi, 1997.
3. E. S. Buffa and R. K. Sarin, *Modern Production / Operations Management*, (8e), Wiley, 1987
4. H. J. Arnold and D. C. Feldman, *Organizational Behavior*, McGraw – Hill, 1986.
5. Aswathappa K, *Human Resource and Personnel Management*, Tata McGraw Hill, 2005.
6. William Wether & Keith Davis, *Human Resource and Personnel Management*, McGraw Hill, 1986.

AU3101: AUTOMOTIVE TRANSMISSION SYSTEMS [3 0 2 4]

Power Required for Propulsion: Resistances to Motion of the Automobile, Traction, tractive effort, Performance curves, acceleration, gradeability, drawbar pull, Numerical Problems. Clutch: Types of clutches, construction and operation of all types, Numerical problems. Gear box: Performance characteristics in different gears, Desirable ratios of 3speed and 4speed gear boxes, Constructional details of different types of gear boxes, Propeller shaft, Differential. Fluid Coupling and Torque converters: Constructional details, performance characteristics, slip, principles of torque multiplication, 3 and 4 phase torque converters, typical hydrodynamic transmission. Epicyclic Transmission: Principle of operation, types of planetary transmission, Calculation of gear ratio in different speeds, Hydrostatic Drives: Principles of hydrostatic drives, different systems of hydrostatic drives, construction and operations. Automatic and Electric Transmissions: Construction and operation.

Lab: Overhaul, routine service , diagnosis and repair of - Clutches, Gear boxes, Transfer box, Universal joint, Constant Velocity joints, Propeller shafts, Differential mechanisms with differential lock and non-slip differential, Types of drive axles, Hydrostatic drive, Hydrodynamic drive- torque converter.

References:

1. K. Singh, *Automobile engineering* Vol.1, Standard Pub, 2012.
2. G.B.S.Narang, *Automobile Engineering*, Khanna publication, New Delhi, 2008.
3. N. Tesla, *Transmission of Power: Polyphase System*, reprint, Forgotten Books, 2018

AU3102: MANUFACTURING TECHNOLOGY [3 0 2 4]

Foundry: Patterns, Molding, Sand casting, Permanent mold casting, Centrifugal casting, Investment casting, Continuous casting, cleaning and casting defects. Metal Forming: Forging, Rolling, Extrusion, Drawing. Sheet Metal Working: Cold, warm and Hot working, Operations and Dies. Welding: Classification, Resistance welding- spot, seam, projection, Arc welding - Metal Arc, TIG, MIG, Submerged Arc, Electro-slag, Friction welding, welding defects. Machining: Single point and multi point cutting tools terminology, Construction, working principle and operations of Machine tools- lathe, milling, drilling, grinding, Introduction and applications of shaper, and planer, Gear manufacturing- milling, hobbing, shaping. CNC machining: Introduction, Classification, sample part programming on Turning and Milling centers, Non-conventional Machining: Working principle, applications, advantages and limitations of Abrasive water jet machining, Electric discharge machining, Ultrasonic machining, Laser beam machining, Electron Beam Machining. Processing of plastics: Extrusion, Injection and Blow molding, Powder metallurgy – steps and applications, Additive manufacturing: Rapid proto typing, Fused Metal Deposition, 3D printing, Production tooling – Jigs and fixtures, principle of location and clamping. Case studies of manufacturing of automotive components.

Lab: Model preparation using foundry, forging and welding techniques. Preparation of turning Models involving common operations using Lathe. Spur gear and helical gear cutting using milling machine. Practice on shaping and grinding machines. Demonstration of machining on CNC turning & milling centers and use of Non-conventional machines.

References:

1. P N Rao, *Manufacturing Technology Vol. I*, (5e), Tata McGraw-Hill, 2018.
2. P N Rao, *Manufacturing Technology Vol. II*, (4e), Tata McGraw-Hill, 2018.
3. S Kalpakijian, S R Schmid, *Manufacturing Engineering and Technology*, (7e), Pearson Education, 2013.
4. M P Groover, *Fundamentals of modern manufacturing, Materials, Processes, and Systems*, (6e), John Wiley, 2015.
5. P Degarmo, Black, Kohser, *Materials and Processes in Manufacturing*, (12e), Wiley, 2017.

AU3103: AUTOMOTIVE DESIGN [3 0 0 3]

Introduction: Auto Design, Various Aspects, Classification, Requirements, general procedure of design, principles of design optimization, Brain storming. Design of flywheel: Determination of the mass of a flywheel for a given co- efficient of speed fluctuation. MI of flywheel, Engine flywheel - stresses on the rim of the flywheels. Design of hubs and arms of the flywheel, turning moment diagram. Design of Engine Components: Design of various cylinder heads and cover plates Design of piston, piston pin, piston rings and their materials, design of connecting rod and its material. Design of crank shaft, crankshaft materials, Design considerations of valve design, intake and exhaust valve design. Design of rocker arm. Design of Brakes: Drum and Disc brakes. Design of Suspension Spring: Design of laminated leaf spring and coil spring. Design of Gears and Gear boxes: Design consideration- Strength of gear teeth, Lewis equation- Dynamic tooth load. Design of Spur Gear and helical gears.

References:

1. R L Norton, *Machine Design: An Integrated Approach*, (4e), Pearson, 2010.
2. J Shigley, *Mechanical Engineering Design*, McGraw Hill New York, 2016.
3. M F Spotts, E T Shoup, L E Hornberger, *Design of Machine Elements*, (8e), Pearson 2003.
4. V B Bhandari, *Design of Machine Elements*, (4e), Tata McGraw Hill Publishing Company, 2017.
5. V B Bhandari, *Machine Design Data Book*, Tata McGraw Hill Publishing Company, 2014.

AU3104: AUTOMOTIVE ELECTRICAL AND ELECTRONICS SYSTEMS [3 1 0 4]

Automotive starter batteries: Functional requirements, operating principle, Pb-acid battery characteristics, maintenance and troubleshooting. Starting System: overview. Starter motor – construction, working principle and circuit, characteristics, maintenance, Integrated Starter Generator systems. Alternator- operating principle, charging circuit, characteristics curves, design, control, relays, voltage regulation. Ignition system: Types, construction & working, Centrifugal and vacuum advance mechanisms, Types and construction of spark plugs, Vehicle wiring circuits, electrical loads, harness, connectors, earthing, electrical safety procedures, Electronic components in vehicles, Electronic Control units, Sensors – measuring principles, sensor types. Actuators- working principles, types. Electromagnetic compatibility (EMC) and interference, Automotive networking.

References:

1. R BOSCH Gmbh., *Bosch Automotive Electrics and Automotive Electronics*, (5e), Springer Vieweg (eBook), 2007.
2. W B Ribbens, *Understanding Automotive Electronics*, (7e), Butterworth-Heinemann (Elsevier), 2012.
3. T Denton, *Advanced Automotive Fault Diagnosis*, (4e), Routledge, 2017.

AU3130: AUTOMOTIVE DESIGN LAB [0 0 2 1]

Introduction to 2D entities, Mechanical Components, Automotive components, Introduction to 3D Entitles, Introduction to Assembly commands, Automotive Components assembly, Rocker Arm Assembly, IC Engine Connecting rod, Engine Cross Head, Screw Jack using design software.

References:

1. S Tickoo, *CATIA V5R17 for engineers & Designers*, Dreamtech Press Publication, 2008.
2. M Michaud, *CATIA Core Tools: computer aided three-dimensional interactive application*, McGraw Hill Peofessional Publication, 2012.
3. K Plantenberg, *An Inroduction to CATIA V6 Release 2012*, Schroff Development Publication, 2011.

AU3131: AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS LAB [0 0 2 1]

Use of electrical and electronic testing & measurement equipment digital multi meter, battery testing for state of charge in-vehicle & outside, battery load testing, hydrometer testing, servicing, charging. Testing, servicing, dismantling, assembly, inspection of Alternator and Starter motor. Electrical wiring diagrams, connectors, fuses, electrical load calculations, identification and replacement of faulty components. Computer based diagnostic equipment: Use of On Board Diagnostic kit for scanning ECU, data scanners, test lights, test LEDs, pulse generators etc. Use of Digital Storage Oscilloscope for diagnosis of voltage, current, sensor outputs. Verifying logic gates (OR, AND,NAND,NOR,EX-OR,NOT) ,characteristics of Full wave rectifier, square wave form in 555 TIME, Characteristics of Thermocouple, Thermistor, Hall effect transducer and inductive pickup, Resistive Temperature Detector, DC servo motor speed control system, programming on microcontroller, interfacing of peripherals.

References:

1. Al Santini, *Bosch Automotive Electricity and Electronics*, (2e), Delmar Cengage, 2013.
2. T Martin, *How to Diagnose and Repair Automotive Electrical Systems*, Motorbooks, 2005.

AU3170: PROJECT BASED LEARNING II [0 0 2 1]

Project-based learning involves students designing, developing, and constructing hands-on solutions to a problem. The educational value of Project based learning is that it aims to build students' creative capacity to work through difficult or ill-structured problems, commonly in small teams. Typically, Project based learning takes students through the following phases or steps: Identifying a problem, Agreeing

on or devising a solution and potential solution path to the problem (i.e., how to achieve the solution), Designing and developing a prototype of the solution, refining the solution based on feedback from experts, instructors, and/or peers. Depending on the goals of the instructor, the size and scope of the project can vary greatly.

SIXTH SEMESTER

AU3201: HEAT TRANSFER [3 1 0 4]

Introduction: Various modes of heat transfer, conductivity and film coefficient of heat transfer, Thermal diffusivity, overall heat transfer coefficient, thermal resistance and conductance. Heat Transfer by conduction: General heat conduction equation ,Linear heat flow through Plane Wall, Composite Walls, radial heat flow through cylinder, Composite Cylinders, Sphere and Composite spheres, critical thickness of insulation. Heat Transfer from Extended Surfaces: Heat transfer from fins of uniform cross section heated at one end or both ends, Efficiency and effectiveness of fin. Heat Transfer by convection: Free and forced convection heat transfer. Heat Transfer by Radiation: Thermal radiation, absorption, reflection and transmission of radiation, Kirchhoff's Law. Wien's displacement Law, Stefan Boltzmann's law, Intensity of radiation, Lambert's cosine law. Heat Exchangers: Classification of heat exchanger. Analysis using LMTD, Effectiveness-NTU Method, fouling mechanism, growth and design to minimize fouling. Heat transfer in IC engines: Radiator construction, Engine Cooling system construction, coolant properties. Design parameters for radiator & water pump design, hoses, Thermostat Valve, Radiators Cap, Radiator fan, Radiator Fan shroud, Surge Tank.

References:

1. P K Nag, *Heat and Mass Transfer*, Tata Mcgraw Hill Education Pvt Ltd, 2011.
2. Y Cengel, A Ghajar, *Heat and Mass Transfer*, Tata Mcgraw Hill Education Pvt Ltd, 2001.
3. S K Som, *Introduction to Heat Transfer*, PHI Learning Pvt Ltd, 2008.
4. V Ganesan, *Internal Combustion Engines*, Tata Mcgraw-hill Education, 2012.

AU3202: ELECTRIC AND HYBRID VEHICLES [3 0 0 3]

Fundamentals of Vehicle Propulsion, vehicle resistances, powertrain characteristics, vehicle performance, braking, tires. Batteries-Types, Parameters, Capacity, Charge / Discharge rate, SOC, DOD, Battery pack Design, Safety issues and hazards. Overview of Electric vehicles - Hybrid Electric vehicles architectures, Types – series, parallel, mild, complex configurations, Plug in hybrid electric vehicle – Design – Drive train, sizing of components. Vehicle simulation (simulation model, standard drive cycles). Electric Machine fundamentals (motional voltage, EMF), simple DC machines (induced voltage, force and torque, DC machine back emf and torque, simple reluctance motor). DC machines, Three phase AC machines. Induction machines. Permanent magnet machines. Switched reluctance machines. Power electronic switches. DC/DC converters. Case studies on EVs and HEVs, Components of DC and AC Charging System for vehicle, Fast Charging, Ultra-Fast charging systems.

References:

1. J D Haldeman, *Hybrid and Alternative Fuel Vehicles*, (2e), Pearson. Education, 2012.
2. I Hussain, *Electric and Hybrid Vehicles: Design Fundamentals*, (2e), CRC Press, 2010.
3. A E Fuhs, *Hybrid Vehicles and the Future of Personal Transportation*, CRC Press, 2009.
4. J German, *Hybrid powered Vehicles*, (2e), SAE International, 2011.

AU3203: QUALITY ASSURANCE AND RELIABILITY ENGINEERING [3 1 0 4]

Introduction to Quality: Definition of quality control, quality assurance, quality audit, dimensions of quality, seven quality tools, type of quality costs, cost of poor quality (COPQ) calculation methodology, General quality control engineering fundamentals. Total Quality Management: Philosophies of quality - Deming, Juran and Crosby, Scope and Principles of TQM, Kaizen teams, Quality Circles, Strategic quality management. Introduction to Statistical Quality Control: Control charts for variables and attributes, process capability. Reliability: Concepts of reliability, Quality and Reliability, Methods of Estimating of Reliability, Field Failure Data Analysis, Failure Rate, Failure Density, Life testing, MTBF, MTTF, Maintainability & Availability, Reliability Allocation - Series Systems, Parallel Systems, Combined Series and parallel Systems. Block Diagrams, Fault tree analysis, Event tree analysis, Design review and validation, Design for reliability.

References:

1. H Gitlow, R Oppenheim, A Oppenheim, D Levine, *Quality Management*, McGraw Hill Education, 2017.
2. E L Grant and R Leavenworth, *Statistical Quality Control*, (7e), McGraw Hill Education, 2017.
3. D C Montgomery, *Introduction to Statistical Quality Control*, (6e), John Wiley and Sons, New York, 2009.
4. C E Ebeling, *An Introduction to Reliability and Maintainability Engineering*, (8e), Tata McGraw-Hill, 2007.

AU3230: COMPUTER INTEGRATED MANUFACTURING LAB [0 0 2 1]

CNC part programing for turning and milling applications, CAM software for simulation and generate cutter location data from CAD models, function and programming for pick and place robot.

Reference:

1. M P Groover, *Automation, Production Systems and Computer Integrated Manufacturing*, Prentice Hall of India, 2008.

AU3231: VEHICLE DYNAMICS SIMULATION LAB [0 0 2 1]

Use of ANSYS Workbench for simulation of Vehicle Dynamic problems. Modelling of components using Design Modeller, Mesh generation, aerodynamic simulation of flow over NACA airfoils, flow in a pipe, aerodynamic drag simulation of a car. Crash Simulation of car, simulation of spring suspension, simulation of alloy wheel.

References:

1. *ANSYS Workbench User Manual*.
2. T Martin, *How to Diagnose and Repair Automotive Electrical Systems*, Motorbooks, 2005.

AU3232: AUTOMOTIVE CONTROL SYSTEMS LAB [0 0 2 1]

Introduction to MATLAB Programming: Basic Operations, vectors, Elementary MATLAB Constructs, Loops and Conditional Statements, Writing Scripts and Functions, 2-D, 3-D Plotting, Polynomial Evaluation, Importing Data, Solution of Differential Equations, Introduction to Simulink: Operating Principle and Solving problems with Simulink, Automotive control system design simulations - Spark-timing control, hybrid vehicle drive cycle, control of fuel cells, Adaptive PI Cruise controller design, Anti-lock braking system controller.

References:

1. A G Ulsoy, H Peng, M Cakmakci, *Automotive Control Systems*, (1e), Cambridge University Press, 2012.
2. A Gilat, *MATLAB-An Introduction with Applications*, Wiley India, 2009.
3. S.J.Chapman, *Programming in MATLAB for Engineers*, Cengage Learning, 2011.

AU3270: PROJECT BASED LEARNING III [0 0 2 1]

Project-based learning involves students designing, developing, and constructing hands-on solutions to a problem. The educational value of Project based learning is that it aims to build students' creative capacity to work through difficult or ill-structured problems, commonly in small teams. Typically, Project based learning takes students through the following phases or steps: Identifying a problem, Agreeing on or devising a solution and potential solution path to the problem (i.e., how to achieve the solution), Designing and developing a prototype of the solution, refining the solution based on feedback from experts, instructors, and/or peers. Depending on the goals of the instructor, the size and scope of the project can vary greatly.

SEVENTH SEMESTER

AU4170: MINOR PROJECT USING LEAN SIX SIGMA [0 0 4 2]

Complete a project by applying Lean Six Sigma methods to Define, Measure, Analyze, Improve and Control the deliverables. DEFINE tools will include – Project Chartering, Project Planning and Management. MEASURE tools will include: establishing baseline to measure improvement, process Mapping, SIPOC, Value Stream Mapping to identify Value Add and Non-Value Add work, Spaghetti diagrams. Measurement System Analysis (MSA), Gage R&R ANALYSIS tools will include: Cause & Effect analysis, FMEA, Process capability analysis and process control (SPC) using Minitab, verify critical inputs using DOE with Minitab. IMPROVEMENT tools will include – establishing single piece flow using Kanban / Pull methods that are trigged by customer demand, Mistake Proofing, Quick Changeover, Workplace Organization, Process Mapping, Process Documentation, piloting a new process to test for improvement. The Control Phase tools and methods will develop a control system to ensure long term sustainability using - Control Plans, Process Documentation, Training Plans, Statistical Process Control and Process Capability.

References:

1. M L George, J Maxey, D T Rowlands, M Upton, *Lean Six Sigma*, McGraw-Hill Education India, 2004.
2. S Shaffie, S Shahbazi, *The McGraw-Hill 36-Hour Course: Lean Six Sigma*, McGraw-Hill 2012.

AU4171: INDUSTRIAL TRAINING [0 0 2 1]

Each student has to undergo industrial training for a minimum period of 6 weeks. This may be taken in a phased manner during the vacation starting from the end of six semester. Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

EIGHTH SEMESTER

AU4270: MAJOR PROJECT [0 0 0 12]

Project work should be carried out for a minimum duration of 16 weeks at the institution/ industry/ research laboratory or any other institution where facilities exist, with approval of the parent Department. The grade awarded to the student will be on the basis of the total marks obtained by him/ her out of 400 marks. There will be a mid-semester evaluation of the work done on the project after 8-10 weeks. In case of external projects, the qualitative feedback of the external guide shall be taken. The final evaluation and viva voce will be conducted after the completion of the project work and submission of the project report, by a panel of examiners including the internal guide.

PROGRAM ELECTIVES

PROGRAM ELECTIVE I

AU3240: ADVANCED INTERNAL COMBUSTION ENGINES [2 0 2 3]

Theory of SI and CI engine combustion – Flame velocity and area of flame front. Fuel spray characteristics – droplet size, depth of penetration and atomization, Combustion analysis in IC engines: Photographic studies of combustion processes – Analysis of Pressure crank angle diagrams in SI and CI engines. Knock study for Pressure crank angle histories. Apparent heat release rate and Wiebe's law analysis for combustion. Calculation of Ignition delay and combustion duration. – Hot wire and laser Doppler anemometry and velocimetry for flow and combustion analysis in IC engines. Combustion of fuels: Chemical composition and molecular structure of hydrocarbon fuels. Combustion Stoichiometry of hydrocarbon fuels – Chemical energy and heat of reaction calculations – Chemical equilibrium and adiabatic flame temperature calculation.

Lab: Combustion Analysis experiments on SI & CI engine by varying CR, Injection Timing, Injection Pressure and blending of fuels. FIP calibration test.

References:

1. J B Heywood, *Internal Combustion Engine Fundamentals*, (India Edition), McGraw Hill Publishers, 2011.
2. V Ganesan, *Internal Combustion Engines*, (4e), McGraw Hill, 2011.
3. K K Ramalingam, *Internal Combustion Engines*, (3e), Scitech Publishers, 2017.

AU3241: VEHICLE BODY ENGINEERING [2 0 2 3]

Car Body: Types of car bodies, limousine, estate car, racing and sports car. Visibility: Regulations, driver's visibility, tests for visibility, methods of improving visibility and space in cars. Safety: Safety design, safety equipment for cars. Car body construction: Design criteria, prototype making, initial tests, crash tests on full scale model, Dummies and Instrumentation. Vehicle Aerodynamics; Objectives. Vehicle drag and types; various types of forces and moments, effects of forces and moments, side wind effects on forces and moments, Various body optimization techniques for minimum drag. Wind tunnel testing: Flow visualization techniques, scale model testing, component balance to measure forces and moments. Bus Body: Types, layout, entrance, exit and seating dimensions. Constructional details: Frame construction, double skin construction, types of metal sections used, Regulations, Conventional and integral type construction. Commercial Vehicle body: Classification, Dimensions of driver's seat relation to controls, Drivers cab design.

Lab: Visibility test, types of tool used, welding process on vehicle body penal, Mechanisms of Door lock , Window winding and Driver seat, Dent removal process, Painting processes, Scale models- Bus body, Mini truck, and cars, Wind tunnel test.

References:

1. J E Duffy, *Body Repair Technology for 4-Wheelers*, Cengage Learning, 2009.
2. D Anselm, *The passenger car body*, SAE International, 2000.
3. J Powloski, *Vehicle Body Engineering*, Business Books Ltd., 1998.

AU3242: COMPUTER INTEGRATED MANUFACTURING AND ROBOTICS [2 0 2 3]

Computer integrated manufacturing system, N.C. Machine tools- classification, working, design considerations, construction requirements, machine accuracy and productivity. Control loops of NC systems, G & M codes for NC and CNC machine, ATC, Co-ordinate systems, point to point and contour programming, conventional NC, interactive graphics, manual data input, Adaptive Control System, Programmable Logic Controller. Industrial robots-Robot anatomy, physical configurations, Manipulator Kinematics, Technical features, Programming, , end effecters, work cell design, internal external sensors, Group Technology, Flexible manufacturing systems , Material Handling System, Computer aided process planning (CAPP).

Lab: Mini project on CNC, Robotics, GT and FMS.

References:

1. M P Groover, *Automation, Production Systems and Computer Integrated Manufacturing*, Prentice Hall of India, 2008.
2. P Radhakrishnan, S Subramanyan, V Raju, *CAD/CAM/CIM*, (2e), New Age, International (P) Ltd, 2010.

AU3243: ARTIFICIAL INTELLIGENCE [2 0 2 3]

Significance of AI in automotive systems, Intelligent agents, Solving problems by searching, Informed search- Greedy Best First Search,

A* Search, Hill Climbing, Uninformed search- Breadth First Search, Depth First Search, Depth Limited Search, Iterative Deepening Depth First Search, Bidirectional Search and comparisons, Adversarial search, Constraint Satisfaction Problems, Knowledge-based agents, Knowledge representation, Quantifying Uncertainty, Probabilistic reasoning, Fuzzy Sets and Fuzzy Logics, AI Techniques: Simulated Annealing, Tabu Search, Genetic Algorithm, Particle Swarm Optimization, Ant Colony Optimization, Artificial Neural Networks, Distributed AI and Multi Agent Systems. Overview of image processing and computer vision.
Lab: Mini projects/Case studies on algorithm Applications.

References:

1. S Russell, P Norvig, *Artificial Intelligence: A Modern Approach*, Pearson Education, 2009.
2. M T Jones, *Artificial Intelligence: A Systems Approach*, Infinity Science Press LLC, 2008.

PROGRAM ELECTIVE II

AU3244: COMPUTER AIDED DESIGN & FEA [2 0 2 3]

Transformations: Introduction, transformation of points and line, 2-D rotation, reflection, scaling and combined transformation, homogeneous coordinates, 3-D scaling, shearing, rotation, reflection and translation, combined transformations. Geometric Modelling: Types and representation of curves, Analytical curves, line, ellipse, parabola, Synthetic curves, Cubic, Bezier and B-spline curves, Types and representation of surfaces, Analytic surfaces, Plane, ruled, revolution and tabulated surfaces, Synthetic surfaces, cubic, Bezier and B-spline surfaces, Types and representation of solids, Solid representation, half spaces, Boundary Representation. Finite Element Analysis: Review of stress- strain relation and generalized Hooke's Law, Plane stress and Plain strain conditions, Concept of Total Potential Energy, Basic procedure for solving a problem using Finite Element Analysis. 1-D Analysis: Concept of Shape function and natural coordinates, strain-displacement matrix, derivation of stiffness matrix for structural problems, 1-D structural problems. Trusses: Formulation of stiffness matrix, simple truss problems to find displacement, reaction and stresses in truss members.
Lab: Structural analysis using Mechanical APDL.

References:

1. I K Zeid, *CAD/CAM Theory and Practice*, (2e), Tata McGraw Hill Publishing Company, 2012.
2. J Srinivas, *CAD/CAM Principles and Applications*, (1e) Oxford University Press, 2017.
3. J N Reddy, *An Introduction to Finite Element Method*, McGraw Hill Publication, 2003.
4. D Logan, *The Frist course in finite element method*, Cengage Learing, 2016.

AU3245: TWO AND THREE WHEELED VEHICLE SYSTEMS [2 0 2 3]

Classification, technical specification and layouts, Selection criteria of power plant, Starting Mechanism/ Procedure, scavenging, exhaust system layouts. Chassis & Sub Systems: Main frame and its types, Chain and shaft drive, Clutches, CVT, gear boxes- Types, purpose, construction and working principle - gear controls & shifting mechanism. Suspension & Steering Handle bar: Construction and working principle of Front and Rear suspension system. Steering mechanisms and Handle bar. Brakes and Wheels: Types, construction and working principle. Rims and Tires – Functions, materials, types, its advantages & comparison. Electrical Systems: Batteries, charging and ignition systems, Lighting and accessories. Instrumentation: Panel meters & controls, Switches, warning indicators / buzzers & actuating levers, Ignition key switch. Road Performance: Road holding & vehicle stability, seating and rider ergonomics, Various Safety measures & arrangements, Brake performance. Two & three wheeler Maintenance: Servicing, periodic check-ups. Trouble shooting, causes and remedies. Electric 2 & 3 wheelers.
Lab: Dismantling & assembling of a two and three wheeled engine, gear box, differential, and suspension system. Carburettors, injection system, Study of Kick starter mechanism Moped cranking mechanism, three wheeler drive line & chassis, wiring diagram & electrical systems, handle bar controls & adjustments, Rear & front brake overhauling & adjustments.

References:

1. D U Panchal, *Two and Three Wheeler Technology*, (2e), PHI Learning Private Limited, 2015.
2. K K Ramalingam, *Two Wheelers*, (2e), Scitech Publications Pvt. Ltd., 2014.
3. A De, *Vehicle Dynamics*, (1e), Galgotia Publications Pvt. Ltd., 2011.

AU3246: AUTOMOTIVE MATERIALS AND MANUFACTURING [2 0 2 3]

Automotive Materials: Overview of engineering materials and material selection criteria for automotive components, Car Body Materials, Materials for Engine Components, Materials for Chassis and Powertrain Components, Automobile Aluminum Sheet, Plastic Technology for Automotive Modules, High-Temperature Electronic Materials, Smart Materials. Automotive Manufacturing: Stamping and Metal Forming Processes. Automotive Joining: Welding- Robotic Fusion-Welding Operations, Adhesive Bonding. Automotive Painting: Immersion Coating Processes, Paint Curing Processes, Painting Spray Booths Operations, Painting Robotics. Final Assembly: Installation of the Trim Assembly and Chassis, Final Assembly and Testing Area, Ergonomics of the Final Assembly Area, Mechanical Fastening and Bolting. Additive manufacturing: 3D printing and materials. Composite manufacturing
Lab: Mini-projects based on selection of materials and manufacturing processes for automobile components.

References:

1. Omar, A Mohammed, *The automotive body manufacturing systems and processes*, John Wiley & Sons, 2011.
2. B Cantor, G Patrick, J Colin, *Automotive engineering: lightweight, functional, and novel materials*, CRC Press, 2008.
3. J ed Rowe, *Advanced materials in automotive engineering*, Elsevier, 2012.

AU3247: DATA ANALYTICS [2 0 2 3]

Probability Theory: Sample Spaces- Events - Axioms – Counting – Conditional Probability and Bayes' Theorem – The Binomial Theorem – Random variable and distributions: Mean and Variance of a Random Variable-Binomial-Poisson-Exponential and Normal distributions. Curve Fitting and Principles of Least Squares- Regression and correlation. Sampling Distributions & Descriptive Statistics: The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Sampling distributions (Chi-Square, t, F, z). Test of Hypothesis- Testing for Attributes – Mean of Normal Population – One-tailed and two-tailed tests, F-test and Chi-Square test - - Analysis of variance ANOVA – One way and two way classifications. Non-parametric tests: Chi-square test; Run test for randomness; One-sample and Two-sample sign tests; Mann-Whitney U-test for independent samples; Wilcoxon Signed-Rank test for paired samples; Kruskal-Wallis test. Design of experiment: definition, objective, strategies, factorial design, designing engineering experiments, ANOVA, EVOP, Fractional, Full and orthogonal Experiments, Taguchi methods for robust Design.

Lab: Practice on Minitab: normality test, hypothesis testing for parametric and non-parametric items, correlation and regression analysis, DoE, factorial design.

References:

1. R A Johnson, I Miller, Freund, *Probability and Statistics for Engineers: Pearson New International Edition*, Pearson Higher Ed, 2013.
2. D C Montgomery, *Design and analysis of experiments*, John Wiley & Sons, 2017.
3. R I Levin, *Statistics for management*, Pearson Education India, 2011.
4. J Hair, R Anderson, B Black, B Babin, *Multivariate data analysis*, Pearson Education, 2016.

PROGRAM ELECTIVE III

AU4140: PRODUCT DESIGN AND DEVELOPMENT [2 0 2 3]

Introduction: New product development, Characteristics, challenges, Economics, Value engineering, concurrent engineering, reverse engineering. Product development process: planning, concept development, system level design, detailed design, testing and refinement, production ramp up. Identifying Voice of Customer: Product opportunity identification, Perceptual mapping, Customer needs, Kano model, Quality function deployment, benchmarking, product specifications, conjoint analysis, Failure mode and effects analysis. Product Architecture: Integral and modular design, Robust design, Industrial design, Design for X – Manufacturing, Assembly, Environment, Six Sigma. Product Lifecycle Management: Concept, Elements and Significance, PLM Strategy, Information flow, PLM Database, life cycle assessment. Intellectual Property Rights: Patents, copyrights, trademarks, geographical indicators.

Lab: Exercises based on idea generation, perceptual mapping, Kano analysis, QFD, conjoint analysis, life cycle assessment, value analysis, and SWOC.

References:

1. K T Ulrich, S D Eppinger, *Product Design and Development*, Tata McGraw Hill, Special Indian Edition, (5e), 2017.
2. A K Chitale, R C Gupta, *Product Design and Manufacturing*, (5e), PHI, 2011.
3. K Otto, K Wood, *Product Design: Techniques in Reverse Engineering and New Product Development*, (1e), Pearson Education, 2004.

AU4141: AUTOMOTIVE AIR CONDITIONING SYSTEMS [2 0 2 3]

Introduction to Air Conditioning : Components of Air conditioners, Operation of an Air-conditioning System, Type of Air conditioners, Heaters, Vehicle ventilation, combination heater and air conditioner, manually controlled air conditioner and heater system, automatically controlled air conditioner and heater systems, Air Heating equipment, Ducts, Registers and Grills, blowers, filters, Trouble Shooting and Services, Servicing of Air Conditioners. Psychrometry: Psychrometric properties and processes, sensible and latent heat loads, characterization and SHF load for ventilation and filtration, concepts of SHF and ESHF and ADP, concepts of human comfort and effective temperature. Automotive Refrigerants: Classification, properties and designation.

Lab:- Tools used for Air conditioning overhauling, service, diagnosis and repair, Overhauling, routine service, diagnosis and repair of compressor, evaporator, condenser, receiver dryer expansion valve, accumulator and orifice, Testing of air conditioning system.

References:

1. B H Dwiggins, *Automotive Air Conditioning*, Cengage Learning, 2001.
2. C P Arora, *Refrigeration and Air Conditioning*, (3e), Tata Mc Graw Hill, 2017.
3. M. Prasad, *Refrigeration and Air Conditioning*, New Age International, 2002.
4. Q Zhang, S E Li, K Deng, *Automotive Air Conditioning: Optimization, Control and Diagnosis*, (1e), Springer, 2016.

AU4142: METROLOGY AND MEASUREMENT SYSTEM ANALYSIS (MSA) [2 0 2 3]

Introduction: measurement system- Units and standards, measuring instruments, sensitivity, readability, accuracy, precision, random errors-correction and calibration. Metrology and Inspection: linear and angular measurement- devices and systems, line and end standards. Limits, Fits and Tolerances: concept, Grades of Tolerances, Fits, Clearance, Interference and Transition. Gauges: Classification, construction, Taylor's Principle of Gauge Design and application, Interchangeability and selective assembly. Comparators: Types, Construction, Design and application. Optical measuring instruments: Principles of design, construction and operation. Measurement of Form Errors: Straightness, Flatness and Square measurement, Indicator method, Engineer's Square tester, Optical Square Screw Threads: Types, Principles of design and application. Surface Texture measurement: Methods, Principles of design and operation. Gear measurement: Gear terminology, Errors in gears, Composite tooth thickness, Gear tooth Vernier calipers, Constant chord method, Base tangent method, using precision rollers. Measurement System Analysis: Measuring instrument and tools calibration gauge study, attribute gauge study, gauge R&R, ANOVA gage R&R, factors affecting measurement systems.

Lab: Linear and angular measurement, Measurement of Form Errors, Measurement system analysis: measuring instrument and tools like calibrated gage study, attribute gage study, gage R&R, ANOVA gage R&R using Minitab software.

References:

1. E O Doebelin, D N Manik, *Doebelin's Measurement systems*, (6e), Tata McGraw-Hill, 2011.
2. A K Bewoor, V A Kulkarni, *Metrology & Measurement*, (16e), McGraw Hill Education, 2016.
3. A K Sawhney, M A Mahajan, *Textbook of measurement and metrology*, Dhanpat Rai & Co. 2014.

PROGRAM ELECTIVE IV

AU4143: AUTOMOTIVE NOISE, VIBRATIONS & HARSHNESS [2 0 2 3]

Introduction to NVH: Noise, Vibration and Harshness (NVH) and its role in automotive design and development. Physiological effects of harshness due to noise and vibration, sources of vibration and noise in automobiles. Basics of Vibration Analysis: Basic concepts, mathematical models, formulating the equations of motion for linear and torsional system characteristics and response – damped and undamped single & two degree of freedom systems under harmonic force, coordinate coupling, generalized coordinates and modal analysis. Vibration Control Techniques: Vibration isolation, tuned absorbers, untuned viscous dampers, damping treatments, Applications: isolation of the engine from vehicle structure and control of torsional oscillation amplitudes in engine crankshaft. Noise Fundamentals: Fundamentals of acoustics – general sound propagation – structure borne sound & air borne sound. NVH Measurements: Vibration and Noise Standards – Pass/Drive by noise, noise from stationary vehicles, interior noise in vehicles, NVH measurement tools and techniques. Automotive Noise Sources and Control Techniques: Methods for control of engine noise, Transmission Noise, Intake and Exhaust Noise, Aerodynamic Noise, Tyre Noise, Brake noise. Noise control strategy, noise control at source – along the path – isolation, damping, balancing, resonators, absorption, barriers and enclosure.

Lab: Mini Projects on Noise isolation.

References:

1. R S Singirisu, *Mechanical Vibration*, Pearson Education, Delhi, 2004.
2. R V Dukkapatti, *Text Book of Mechanical Vibration*, Prentice Hall of India Ltd, 2004.
3. I J Daniel, *Engineering Vibration*, Prentice Hall, New Delhi, 2001.
4. G Shen, *Vehicle Noise, Vibration and Sound Quality*, SAE international, Warrendale, Pennsylvania, 2012.
5. M Harrison, *Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles*, Mathew Harrison Publication, 2004.

AU4144: EARTH MOVING EQUIPMENT [2 0 2 3]

Classification and requirements of off road vehicles: Land clearing machines, Earth moving machines Scrapers and graders, Shovels and ditcher's Power plants, chassis and transmission, multi axle vehicles. Transport equipment: Powered equipment, Tractors and Trollies, Trailers, Platform lift trucks, Fork lift trucks, containers and Supports. Hauling equipment: Type of dump trucks, On-road and Off-road way vehicles. Hoisting equipment: Jacks, truck mounted crane, Crawler crane, Outriggers. Tractors and tractors units: Tractors in earth moving Applications of tractors, Rating of Tractors, Wheeled and Crawler tractor, recent trends in tractor design, power shift transmission and final drive in caterpillar tractor. Motor grader: recent trends, control mechanism of a caterpillar motor grader. Earth moving machines: Bulldozers, cable and hydraulic dozers. Crawler track, running and steering gears, scrapers, drag and self-Powered types - dump trucks and dumpers - loaders, single bucket, multi bucket and rotary types - power and Capacity of earth moving machines.

Lab: Hydraulic trainer explains the hydraulic principle used in crawler tractor, power shift transmission and final drive. Pneumatic trainer explains the circuit used in pneumatic brake system used in heavy vehicle.

References:

1. V Mahesh, *Construction Equipment and its Planning and Applications*, Metropolitan Books Co., Delhi, 2004.
2. H Nichols, D Day, *Moving the Earth: The Workbook of Excavation*, (6e), McGraw-Hill Education, 2010.
3. S C Jain, C R Rai, *Farm Tractor: Maintenance and Repair*, Standard Publishes-Distributors, 2012.

4. D N Sharma, S Mukesh, *Design of Agriculture Tractor*, (4e), Jain Brothers, 2012.
5. H Taghavifar, A Mardani, *Off-road Vehicle Dynamics*, (1e), Springer International Publishing, 2017.

AU4145: OPTIMIZATION TECHNIQUES [2 0 2 3]

Introduction to optimization; Linear Programming: Statement of LP problem, graphical method, Simplex method, Degeneracy, Duality, Post Optimal and Sensitivity Analysis. Allocation problems: Transportation model, Assignment model, Trans-shipment; Waiting Line Models: Classification, States in queue, Probability distribution of arrivals and service times, Single server model (M/M/l), Multiple server model (M/M/S), Single server model with finite capacity; Game Theory: Rectangular, Two persons Zero sum games, Maximin and Minimax Principles, Saddle point, Dominance, Graphical and Algebraic methods, Solution by transforming into LPP. Integer Programming: cutting plane method, branch and bound method; Introduction to Goal Programming, Dynamic Programming, and Simulation.

Lab: Exercises using Tora software.

References:

1. S S Rao, *Engineering Optimization: Theory and Practice*, (3e), New Age International Publishers, 2013.
2. H A Taha, *Operations Research; An Introduction*, (9e), Pearson Publication, 2014.
3. W L Winston, *Operations Research: Applications and Algorithms*, (4e) Thomson Learning, 2004.
4. J C Pant, *Introduction to Optimization techniques*, (7e), Jain Brothers, 2008.

PROGRAM ELECTIVE V

AU4146: VEHICLE ERGONOMICS AND SAFETY SYSTEMS [2 0 2 3]

Introduction, Anthropometry and Biomechanics in vehicle design, Occupant packaging- seating layout, key dimensions, Reference points, Ingress & egress, Driver Information Acquisition and Processing, positioning of Controls & Displays, Field of View, Automotive Lighting - headlight, signals, dazzling & preventive methods. Crashworthiness- crumble zones & vehicle structure, regulations & tests, Seat Belts, Air Bags, Active safety technologies- Collision detection and avoidance, Detection of Lane departure warning, blind spot & object detection, Antilock Brakes (ABS), Electronic Stability (ESP).

Lab: Exercises and mini projects using Technomatix and Excel software.

References:

1. V D Bhise, *Ergonomics in the Automotive Design Process*, CRC Press, 2012.
2. P D Bois, *Vehicle Crashworthiness and Occupant Protection*, American Iron and Steel Institute, 2004.
3. K Reif, *BOSCH Automotive Mechatronics*, Springer Vieweg, 2015.
4. R Jurgen, *Automotive Electronics Handbook*, McGraw Hill, 2000.

AU4147: AUTOTRONICS AND AUTONOMOUS VEHICLES [2 0 2 3]

Application of electronics in Automobiles: Architecture of vehicle electronic systems, Motronic engine-management systems, ECUs, Automotive networking, BUS systems, Sensors- types, measuring principle, Actuators. Electronic Transmission control, Anti-lock braking system (ABS), Traction Control system (TCS), Electronic Stability Program (ESP), Electronic Diesel Control (EDC), Vehicle Security Systems, On-Board Diagnosis systems. Components of Autonomy in cars, control in autonomous system, system architecture, sensors, estimation, Localization and Mapping, navigation and path planning, Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) Communications and Cooperative Driving, Traffic Control and Traffic Management in a Transportation System with Autonomous Vehicles, Risk Based Navigation Decisions, Intelligent Vehicle Potential and Benefits.

Lab: Exercises and mini projects using MATLAB.

References:

1. K Reif, *Automotive Mechatronics (BOSCH)*, Springer Vieweg, 2015.
2. R BOSCH Gmbh. *Automotive Electrics and Automotive Electronics (BOSCH)*, (5e), Springer Vieweg, 2007.
3. L Vlacic, M Parent, *Intelligent Vehicle Technologies*, (1e), Butterworth-Heinemann, 2001.
4. U Ozguner, T Acarman, K Redmill, *Autonomous Ground Vehicles*, (1e), Artec House, 2011.

AU4148: PRODUCTION AND OPERATIONS MANAGEMENT [2 0 2 3]

Forecasting: Need for forecasting, Quantitative methods. Capacity and aggregate planning: Capacity measurement, Long-term and short term strategies, Aggregate planning. Inventory management: Various costs in inventory management and need, Deterministic models and discounts, Probabilistic inventory management. Scheduling: Models and applications, Scheduling in MRP system, Sequencing rules and applications, Batch production sequencing and scheduling, line balancing models. Facility layout and location: Qualitative aspects, Quantitative models for layout decisions. Product, process fixed position, group layout. Location decisions-quantitative models. Project Management: Project Management principles, utilizing work breakdown structures (WBS) to identify project schedule, different types of project management methods, scheduling using Gantt Charts, PERT/CPM.

Lab: Mini-projects and case studies.

References:

1. R B Chase, N J Aquilano, F R Jacobs, *Operation Management for Competitive Advantage*, (9e), Tata McGraw-Hill, Delhi, 2002.
2. D A Collier, J R Evans, *Operations Management*, Cengage Learning, 2016.
3. J Heizer, B Render, *Operations Management*, Pearson, 2013.
4. R R Venkataraman, J K Pinto, *Operations Management: Managing Global Supply Chains*, Sage Publisher, 2017.

PROGRAM ELECTIVE VI

AU4149: COMPUTATIONAL FLUID DYNAMICS [2 0 2 3]

Introduction to CFD, Objectives, philosophy of CFD, application of CFD in automobile engineering. Conservation laws of Fluid Dynamics, continuity, momentum and energy equations, Classification and Mathematical behavior of PDEs, Conservative and Non-conservative forms, Structured and Staggered grid, Implementation of boundary conditions. Discretization Process- concept and structure, Finite Volume methods. Diffusion and Convection-Diffusion Problems, Upwind, Hybrid and QUICK schemes. Solution algorithms: SIMPLE, SIMPLEC, TDMA, Point Iterative Methods, Explicit methods- Crank Nicolson, Implicit methods. Errors and Uncertainty in CFD.
Lab: Mini Projects based on ANSYS - Fluent.

References:

1. S V Patankar, *Numerical Heat Transfer and Fluid Flow*, (1e), Hemisphere- McGraw Hill,Reprint- 2017.
2. H K Versteeg, W Malalasekera, *An Introduction to Computational Fluid Dynamics*, Pearson, 2008.
3. K.Muralidhar, T.Sundararajan, *Computational Fluid Flow and Heat Transfer*, Narosa Publishing House, 2009.

AU4150: AUTOMOTIVE SERVICE OPERATIONS [2 0 2 3]

Service office Management: Service Parameters- Customer engagement index, technician skill enhancement, Function and role of service advisor and area technical lead. Warranty Processing system, Spare Parts Management at dealership, Customer Care management at service center.
Lab: Case study about enhancement customer satisfaction index (CSI) through improve service operation.

References:

1. A Chikara*, Automobile Marketing & workshop techniques: Automobile Engineering Vol-3*, Satya publication, 2016.
2. A Rezin, *Automotive Service Management- Principle to service*, PHI publication, 2018.
3. C E Oven, *Basic Automotive Service and System*, Delmar Cengage Learning, 2015.
4. A A Rezin, *Automotive Service Management Principles into Practice*, (3e), Pearson, 2013.
5. J A Doshi , *Vehicle Maintenance and Garage Practice*, PHI Publication, 2017.

AU4151: STASTISTICAL PROCESS CONTROL AND STASTICAL QUALITY CONTROL [2 0 2 3]

Introduction: Statistical Methods for Quality Control and Improvement; Methods and Philosophy of Statistical Process Control: Variation, cause of variation, Types of Variation. Control Charts: Basic principles, choices of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts, warning limits, sensitizing rules for control charts. Control Charts for Variables: Control Charts for X bar and R, X bar and S, Individual Measurements - development and use, estimating process capability, interpretation and average run length, Applications of Variables Control Charts. Control Charts for Attributes*:* Control Chart for Fraction - p, np c and u chart, Implementing SPC: An Application of SPC, Nonmanufacturing application of SPC. ImR and X-bar & R-charts, Guideline for Implementing Control charts. Acceptance Sampling: OC curve, the OC function and ARL calculation; Lot-By-Lot Acceptance Sampling For Attributes: Concept of sampling inspection and acceptance Sampling, Comparison with 100% Inspection, Cost of inspection, sampling by attributes – Single, Double and Multiple sampling plans, Operating characteristic curve, AOQ curve, AOQL, Producer's and Consumer's risks,, Dodge-Romig and MIL-STD acceptance sampling tables. Process Capability Analysis: Analysis using a histogram or a probability plot, process capability ratios, Cpk, Cp, Ppk, Pp, confidence interval for process-capability ratio, PCA using a control chart, estimating natural tolerance limits of a process.
Lab: Mini projects using Minitab.

References:

1. E L Grant, R Leavenworth, *Statistical Quality Control*, (7e), McGraw Hill Education, 2017.
2. D C Montgomery, *Introduction to Statistical Quality Control*, (6e), John Wiley and Sons, New York, 2009.
3. A Mitra, *Fundamentals of Quality Control and Improvement*, (3e), Wiley India, 2013.

AU 14152: MACHINE LEARNING [2 0 2 3]

Introduction to Machine Learning. Python for Machine Learning, Supervised vs Unsupervised, Regression, Simple Linear, Non Linear, Multiple Linear Regression, Model Evaluation, Evaluation Metrics. Classifications, K-Nearest Neighbours, Decision Trees, Building Decision Trees, Logistic regression vs Linear regression, Support Vector Machine, Clustering, k-Means, Hierarchical Clustering,

DBSCAN, Recommender Systems, Content-based Recommender Systems, Collaborative Filtering,
Lab: Minor Projects based on Python programming.

References:

1. A C Muller, S Guido, *Introduction to Machine Learning with Python*, (1e), O'Reilly, 2016.
2. E Alpaydin, *Introduction to Machine Learning*, (2e), MIT Press, 2010.
3. M Kubat, *An Introduction to Machine Learning*, (1e), Springer, 2015.

PROGRAM ELECTIVE VII

AU4153: ALTERNATIVE FUELS AND ENERGY SYSTEMS [2 0 2 3]

Need for alternative fuels. World and Indian energy scenario on alternative fuels. Availability of different alternative fuels for SI and CI engines. Alcohols: Production methods, Properties, Methods of using alcohols in CI and SI engines. Performance emission and combustion characteristics. Vegetable oils: Various vegetable oils and their important properties, methods of using vegetable oils engines – Blending, preheating Transesterification and emulsification of Vegetable oils, Performance, Emission and Combustion Characteristics in diesel engines. Role of Nano fluids, additives and cetane improvers for performance improvement of vegetable oils as fuel. Hydrogen: Production methods, Combustive properties, Problems associated with hydrogen, Different methods of using hydrogen in SI and CI engines, Performance, emission and combustion analysis in engines. Biogas, LPG and Natural gas: Production methods, Properties, CO2 and H2S scrubbing in Biogas., Modification required to use in SI and CI Engines- Performance and emission characteristics SI and CI engines. Energy Systems: Introduction to Solar Energy conversion, solar cells, fuel cells and super capacitors & their role in automobiles.

Lab: Combustion Analysis experiments on SI & CI engine by varying CR, Injection Timing, and Injection Pressure using in-house made bio-diesels.

References:

1. S S Thipse, *Alternative Fuels*, (India Edition), Jaico Publications, 2013.
2. M A Gajendra Babu, K A Subramanian, *Alternative Transportation Fuels*, CRC Press, 2013.

AU4154: AUTOMOTIVE POLLUTION AND CONTROL [2 0 2 3]

Introduction: Pollutants – sources, formation, effects of pollution on environment& human, transient operational effects on pollution, Regulated &Unregulated emissions - Emission Standards - Introduction to BS-VI. Emissions in SI Engine: Chemistry of SI engine combustion, HC and CO formation in SI engines, NO formation in SI engines, Smoke emissions from SI engines, Effect of operating variables on emission formation. Emissions in CI Engine: Smoke emission and its types, NOx emission and its types, Particulate, Odor, sulfur and Aldehyde emissions, effect of operating variables on emission formation. Control Techniques for Reduction of Emission: Design modifications, Optimization of operating factors, Fuel modification , Evaporative emission control, Exhaust gas recirculation, DOC, SCR, Fumigation, Secondary Air injection, PCV system, Particulate Trap, CCS, Exhaust treatment in SI engines, Thermal reactors, Catalytic converters, Catalysts, Noise reduction devices. Test Procedure, Instrumentation & Emission Measurement: Test procedures CVS1, CVS3, Test cycles – IDC, ECE, FTP, NDIR analyser, Flame ionization detectors, Chemiluminescent analyzer – Dilution tunnel - Gas chromatograph – Smoke meters –SHED test.

Lab: Smoke & 5 gas emission tests from SI & CI engine under different CR, Injection timing, Injection Pressure, varous blends of fuels and blends of bio-diesel.

References:

1. B P Pundir*, IC Engine Combustions and Emissions*, Narosa Publications, 2018.
2. B P Pundir, *Engine Emissions*, Narosa Publications, 2018.
3. P S Myers, *Engine Emissions: Pollutant Formation and Measurement*, Springer US, 2009.

AU4155: VEHICLE FAULT DIAGNOSIS AND TROUBLESHOOTING [2 0 2 3]

Different diagnosis approaches, Type and identification of faults, Tools and garage equipment used in fault diagnosis, overhauling and maintenance, Fault diagnosis techniques for automotive subsystems, diagnostic codes. Troubleshooting: identification and troubleshooting of engine, other sub systems and vehicle body, Safety measures during vehicle troubleshooting. Automotive maintenance practices.

Lab: Garage layouts, Fault diagnosis and troubleshooting practices for automotive systems.

References:

1. W H Crouse, *Automotive mechanics*, (10e), McGraw Hill Education, 2017.
2. T Denton, *Automotive Fault Diagnosis*, (4e), Routledge, 2016.
3. A Chikara, *Vol-1 Automotive Marketing and workshop Practice*, Staya Publication, 2012.
4. R K Rajput, *Automobile Engineering*, (5e), Laxmi Publication, 2015.
5. R B Gupta, *Automobile Engineering*, (4e), Satya Publication, 2015.

AU4156: AUTOMATIC CONTROL SYSTEM [2 0 2 3]

Introduction to Control Theory, Mathematical Models of Electrical: mechanical and electro-mechanical systems, block diagram - signal flow graphs, Mason's gain formula, Time Response: transient response specifications of second order systems, system response with additional pole & zero, Steady state error non- unity feedback systems, Sensitivity Stability: Routh - Hurwitz criterion, frequency domain specifications, Automotive Control System design process, Powertrain Control systems for air-fuel ratio, spark timing, idle-speed, transmission control, Vehicle Control System for cruise and headway, vehicle stability, active suspension, ABS, Traction control, Intelligent transportation systems, advanced vehicle control system, longitudinal and Lateral motion control.

Lab: Introduction of PLC, Automatic opening and closing door, Verify the Operation of Different Logic Gates, Direct online Starter.

References:

1. A G Ulsoy, H Peng, M Cakmakci, *Automotive Control Systems*, (1e), Cambridge University Press, 2012.
2. U Kiencke, L Nielsen, *Automotive Control Systems*, (2e), Springer, 2005.
3. R Bishop, *Intelligent Vehicle Technology and Trends*, (1e), Artec House, 2005.
4. F D Petruzella, *Programmable Logic Controllers*, McGraw Hill Education, 2010.

OPEN ELECTIVES

AU2080: FUNDAMENTALS OF AUTOMOBILE ENGINEERING [3 0 0 3]

Evolution of Automobile engineering, Automotive engines, different types of chassis and frame, ignition system, lubrication system, carburettor and injection system. Steering systems and axles: Steering systems, Front Axles, Rear axles, Brake Introduction, classification, construction, function, operation of mechanical, hydraulic, disc, drum, Power brakes, Air brakes, vacuum brakes. Transmission System: clutch, Gear box and differential, Suspension: construction, operation and spring materials, leaf springs, coil springs, torsion bar, rubber springs, air bellows, pneumatic suspension, hydraulic suspension, Wheels and Tyres. Basic wiring diagram of vehicle electrical system, Vehicle air conditioning: Introduction, construction and working of compressor, condenser, evaporator and expansion devices.

References:

1. S K Gupta, *A text book of automobile engineering*, S. Chand, 2014.
2. K Singh, *Automobile engineering- (Vol.1)*, Standard Publication Distributor, 2012.
3. R B Gupta, *Automobile engineering*, Satya Prakashan, 2012.
4. N K Giri, *Automotive Mechanics*, Khanna Publications, 2003.

AU2081 FUNDAMENTALS OF ELECTRIC AND HYBRID VEHICLE [3 0 0 3]

Fundamentals of Vehicle Propulsion, vehicle resistances, powertrain characteristics, vehicle performance, braking, tires. Batteries- Types, Parameters, Capacity, Charge / Discharge rate, SOC, DOD, Battery pack Design, Safety issues and hazards. Overview of Electric vehicles - Hybrid Electric vehicles architectures, Types – series, parallel, mild, complex configurations, Plug in hybrid electric vehicle – Design – Drive train, sizing of components. Vehicle simulation (simulation model, standard drive cycles). Electric Machine fundamentals (motional voltage, EMF), simple DC machines (induced voltage, force and torque, DC machine back emf and torque, simple reluctance motor). DC machines, Three phase AC machines. Induction machines. Permanent magnet machines. Switched reluctance machines. Power electronic switches. DC/DC converters. case studies on EVs and HEVs, Components of DC and AC Charging System for vehicle, Fast Charging, Ultra-Fast charging systems

References:

1. J D Haldeman, *Hybrid and Alternative Fuel Vehicles*, (2e), Pearson. Education, 2012.
2. I Hussain, *Electric and Hybrid Vehicles: Design Fundamentals*, (2e), CRC Press, 2010.
3. A E Fuhs, *Hybrid Vehicles and the Future of Personal Transportation*, CRC Press, 2009.
4. J German, *Hybrid powered Vehicles*, (2e), SAE International, 2011.
5. M Ehsani, Y Gao, A Emadi, *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals*, Theory, and Press, 2009.

AU2082: LEAN SIX SIGMA PROBLEM SOLVING [3 0 0 3]

Introduction to Six Sigma, Lean, Lean Six Sigma and DMAIC (Define, Measure, Analysis, Improve & Control); Linking Lean Six Sigma to Strategy and Project Selection as it pertains to the Internship program, Understand the Lean Six Sigma Roadmap – Define, Measure, Improve, Control; Actions required for completing the Define Phase – Project Definition, Prioritize projects based on value, resources required, timing, Select projects with buy in from Industry sponsoring internship. Establish accountability between business and student intern. Develop and present project charter. Utilize 8 Disciplines (8D) problem solving team based methodology for a live problem and report out using industry standard methods.

References:

1. M L George, J Maxey, D T Rowlands, M Upton*, Lean Six Sigma*, McGraw-Hill Education India, 2004.
2. S Shaffie, S Shahbazi, *The McGraw-Hill 36-Hour Course: Lean Six Sigma*, McGraw-Hill 2012.

AU2083: TRENDS IN VEHICLE STYLING AND ERGONOMICS [3 0 0 3]

Introduction to styling Car Design, Fundamentals of perspective drawing, Automotive Sketching, Styling process, Car proportions, Aerodynamics, Crashworthiness and its influence on body design, Designing of Interiors Form studies Form studies, Speed Forms, Clay Modeling, 2D systems, 3D systems Fundamentals of Ergonomics Dimension Determination, Anthropometry – Need, Data collection methodology, Different postural considerations, Measuring Procedures Subject and Sampling size selection, Measurement of Hands/Feet/Full posture, Applying Anthropometry data, Application of percentile curves Vehicle Ergonomics Passenger Compartment, Floor Pan, Technical requirements, Dash board equipments arrangement, Positioning of operational controls, Force Analysis, Seating and position(ECE Regulations),Human Factors, Navigation systems, pedal positioning Vehicle Packaging R-Point, AHP, Manikin positioning of 2-D pattern, car entry/exit, Sight – All round visibility, View of Instruments, Mirror design, Logical formation of cockpit, Boot lid packaging, Loading/Unloading analysis.

References:

1. V D Bhise, *Ergonomics in the Automotive Design Process*, CRC Press, 2012.
2. P D Bois, *Vehicle Crashworthiness and Occupant Protection*, American Iron and Steel Institute, 2004.
3. K Reif, *BOSCH Automotive Mechatronics*, Springer Vieweg, 2015.

AU3080: ENGINE EMISSIONS AND CONTROL [3 0 0 3]

Introduction: Pollutants – sources, formation, effects of pollution on environment& human, transient operational effects on pollution, Regulated &Unregulated emissions - Emission Standards - Introduction to BS-VI. Emissions in SI Engine: Chemistry of SI engine combustion, HC and CO formation in SI engines, NO formation in SI engines, Smoke emissions from SI engines, Effect of operating variables on emission formation. Emissions in CI Engine: Smoke emission and its types, NOx emission and its types, Particulate, Odor, sulfur and Aldehyde emissions, effect of operating variables on emission formation. Control Techniques for Reduction of Emission: Design modifications, Optimization of operating factors, Fuel modification , Evaporative emission control, Exhaust gas recirculation, DOC, SCR, Fumigation, Secondary Air injection, PCV system, Particulate Trap, CCS, Exhaust treatment in SI engines, Thermal reactors, Catalytic converters, Catalysts.

References:

1. B P Pundir, *IC Engine Combustions and Emissions*, Narosa Publications, 2018.
2. B P Pundir, *Engine Emissions*, Narosa Publications, 2018.
3. P S Myers, *Engine Emissions: Pollutant Formation and Measurement*, Springer US, 2009.

AU3081: AUTOMOTIVE MATERIALS AND MANUFACTURING PROCESSES [2 0 2 3]

Automotive Materials: Overview of engineering materials and material selection criteria for automotive components, Car Body Materials, Materials for Engine Components, Materials for Chassis and Powertrain Components, Automobile Aluminum Sheet, Plastic Technology for Automotive Modules, High-Temperature Electronic Materials, Smart Materials. Automotive Manufacturing: Stamping and Metal Forming Processes, Automotive Joining: Welding- Robotic Fusion-Welding Operations, Adhesive Bonding. Automotive Painting: Immersion Coating Processes, Paint Curing Processes, Painting Spray Booths Operations, Painting Robotics. Final Assembly: Installation of the Trim Assembly and Chassis, Final Assembly and Testing Area, Ergonomics of the Final Assembly Area, Mechanical Fastening and Bolting. Additive manufacturing: 3D printing and materials. Composite manufacturing.

References:

1. Omar, A Mohammed, *The automotive body manufacturing systems and processes*, John Wiley & Sons, 2011.
2. B Cantor, G Patrick, J Colin, A*utomotive engineering: lightweight, functional, and novel materials*, CRC Press, 2008.
3. J ed Rowe, *Advanced materials in automotive engineering*, Elsevier, 2012.

AU3082: AUTOTRONICS [3 0 0 3]

Application of electronics in Automobiles: Architecture of vehicle electronic systems, Motronic engine-management systems, Electronic Control Units, Automotive networking, BUS systems, Automotive Sensors- types, measuring principle, Electric Actuators, Electronic Transmission control, Anti-lock braking system (ABS), Traction Control system (TCS), Electronic Stability Program (ESP), Electronic Diesel Control (EDC), Sensotronic Brake Control, Vehicle Security Systems, On-Board Diagnosis systems.

References:

1. K Reif, *Automotive Mechatronics (BOSCH)*, Springer Vieweg, 2015.
2. R BOSCH Gmbh. *Automotive Electrics and Automotive Electronics (BOSCH)*, (5e), Springer Vieweg, 2007.
3. L Vlacic, M Parent, *Intelligent Vehicle Technologies*, (1e), Butterworth-Heinemann, 2001.

AU3083: PROCESS CONTROL AND RELIABILITY ENGINEERING [3 0 0 3]

Introduction to Quality: Definition of quality control, quality assurance, quality audit, dimensions of quality, seven quality tools, type of quality costs, cost of poor quality (COPQ) calculation methodology. Quality Control: concept of variation, causes of variation, types of variation, control charts for variables: X-bar chart and R chart, control chart for attributes: p-chart and c-chart, process capability indices, performance capability indices. Acceptance Sampling: Introduction, Single and double sampling plan, operating characteristic curve, AOQ

curve, AOQL, Average Total Inspection, Average Fraction Inspected, ASN curve, Producer's and Consumer's risks. Reliability: Concepts of reliability, Quality and Reliability, Failure Rate, Failure Density, Life testing, MTBF, MTTF, Maintainability & Availability, Hazard functions, Reliability Allocation - Series Systems, Parallel Systems, Combined Series and parallel Systems.

References:

1. A Mitra, *Fundamentals of Quality Control and Improvement*, (3e), Wiley India, 2013.
2. E L Grant, R Leavenworth, *Statistical Quality Control*, (7e), McGraw Hill Education, 2017.
3. D C Montgomery, *Introduction to Statistical Quality Control*, (6e), John Wiley and Sons, New York, 2009.
4. C E Ebeling, *An Introduction to Reliability and Maintainability Engineering*, (8e), Tata McGraw-Hill, 2007.

AU3084: VEHICLE MAINTENANCE AND GARAGE PRACTICE [3 0 0 3]

Maintenance Objectives, classification, preventive, running and breakdown maintenance, maintenance schedules, workshop manuals, owner's manual, Warranty Procedures, Pre-delivery inspection (PDI): front manager, service advisor: functions and duties. Condition Based Maintenance (CBM): Benefits, Objectives, Principles, Techniques, manual inspections. Vehicle Maintenance Tools and Equipment's: denting tools, painting, testing and Service equipment. Maintenance: schedule for engine and drive line, Cooling and lubrication system, braking, suspension and steering systems. Engine Overhauling: Procedure for engine removal from vehicle; disassembly; cleaning procedures; agents; Decarburizing; Top overhauling; Visual inspection; inspection by measurement. Wheels and Tyres: wheel balancing and alignment, tyre specifications and maintenance.

References:

1. J Doshi, *Vehicle Maintenance and Garage Practice*, (4e), EEE, 2017.
2. R K Rajput, *Automobile Engineering*, (6e), Laxmi Publication, 2012.
3. N K Giri, *Automotive Mechanics*, Khanna Publication, 2015.
4. A Chikara, *Vol-3- Automotive marketing and workshop practice*, Satya Publications, 2018.

AU3085: AUTOMOTIVE SAFETY SYSTEMS [3003]

Automotive safety– Introduction and Types. Passive safety concepts: Design of body for safety, deceleration of vehicle and passenger, crumple zone, safety cage. Optimum crash pulse, deceleration on impact with stationary and movable obstacles, deformation behaviour of vehicle body and lightweight materials. Passive safety equipment and convenience system: Seat belt system, collapsible steering column, Air bags, automotive bumpers, steering and mirror adjustment, central locking system, Tire pressure monitoring system, rain sensor system, automated wiper system. Active safety: Antilock braking system, Stability Control, Adaptive cruise control, Lane Keep Assist System, Collision warning, avoidance system, Blind Spot Detection system, Driver alertness detection system.

References:

1. R Jurgen, *Automotive Electronics Handbook*, McGraw Hill, 2000.
2. G Peters, B Peters, *Automotive Vehicle Safety*, CRC Press, 2014.
3. S Ulrich, *Automotive Safety handbook*, SAE International, 2013.

AU3086: TOTAL QUALITY MANAGEMENT [3 0 0 3]

Meaning of Quality, Customer Satisfaction and TQM, Philosophies of Quality - Deming, Juran And Crosby, Scope and Principles of TQM, Cost of Quality and its Relevance to TQM; TQM for Middle Management: Process Management, Statistical Process Control (SPC)- control charts for variables and attributes, process capability, acceptance sampling; TQM for Workforce: Kaizen teams, Quality Circles; TQM for Leadership: Strategic Quality Management, Competitive Advantage; Tools used in TQM - Seven tools, QFD, FMEA; Quality Auditing, ISO 9000 and 14000 Standards.

References:

1. F Gryna, R Chua, *Juran's Quality Planning and Analysis for Enterprise Quality*, McGraw Hill Education, 2017.
2. J M Juran, J A DeFeo, *Juran's Quality Handbook*, McGraw Hill Education, 2017.
3. E L Grant, R S Leavenworth, *Statistical Quality Control*, McGraw Hill Education, 2017.
4. H Gitlow, R Oppenheim, A Oppenheim, D Levine, *Quality Management*, McGraw Hill Education, 2017.

AU3087 PRODUCT DEVELOPMENT [3 0 0 3]

New product development: Introduction, characteristics and challenges, concurrent engineering, reverse engineering. Product development process: planning, concept development, system level design, detailed design, testing and refinement, production ramp up. Identifying Voice of Customer: Product opportunity identification, Perceptual mapping, Customer needs, Kano model, Quality function deployment, product specifications, failure mode and effects analysis. Product Architecture: Integral and modular design, Robust design, Industrial design, Design for X – Manufacturing, Assembly, Environment, Six Sigma. Product Lifecycle Management: Concept, Elements, Significance and Strategy, Life cycle assessment. Intellectual Property Rights: Patents, copyrights, trademarks, geographical indicators.

References:

1. K T Ulrich, S D Eppinger, *Product Design and Development*, Tata McGraw Hill, Special Indian Edition, (5e), 2017.
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