

BE AUTOMOBILE ENGINEERING

SEMESTER - 1

19A101 CALCULUS AND ITS APPLICATIONS

3 1 0 4

DIFFERENTIAL CALCULUS : Function of two variables, limits and continuity, partial derivatives, chain rule, extreme values and saddle points, Lagrange multipliers, Taylor's formula for two variables. (9 + 3)

INTEGRAL CALCULUS : Double integrals — double and iterated integrals over rectangles, double integrals over general regions, Fubini's theorem, area and volume by double integration, reversing the order of integration, polar form. (9 + 3)

FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS : Basic concepts, separable differential equations, exact differential equations, integrating factors, linear differential equations, modeling - mixing problems, Newton's law of cooling. (9 + 3)

SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS : Homogeneous linear equations of second order, homogeneous linear ODEs with constant coefficients, Euler–Cauchy equations, solution by variation of parameters, free oscillations of mass-spring systems. (9 + 3)

VECTOR CALCULUS : Gradient and directional derivative of a scalar field, divergence and curl of a vector field. Integration in vector field — line integrals, path independence of line integrals, Green's theorem in the plane, divergence theorem of Gauss and Stokes's theorems. (9 + 3)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. Joel Hass, Christopher Heil, Maurice D.Weir "Thomas' Calculus", Pearson Education., New Delhi, 2018
2. Erwin Kreyszig "Advanced Engineering Mathematics", Wiley India Pvt Ltd., New Delhi, 2015

REFERENCES:

1. Howard Anton, Irl Bivens, Stephen Davis "Calculus", John Wiley & Sons, INC., USA, 2016
2. Wylie C R and Barrett L C "Advanced Engineering Mathematics", Tata McGraw-Hill., New Delhi, 2019
3. Michael D.Greenberg "Foundations of Applied Mathematics", Dover Publications, INC., New York, 2013
4. Gilbert Strang "Calculus", Wellesley Cambridge Press., USA, 2017

19A102 PHYSICS

3 0 0 3

MECHANICS : Introduction to vectors — velocity and acceleration vectors in two dimensions; Newton's laws of motion - mass, inertia and force, application of Newton's second and third laws in two dimensions - free body diagram, work done by a varying force, work-kinetic energy theorem; System of particles - centre of mass in one and two dimensions; Rotational motion - radial and tangential acceleration, torque, rotation energy, conservation of angular momentum, gyroscopes and precession. (9)

OSCILLATORY MOTION AND WAVE MOTION : Oscillatory motion: Simple harmonic motion, spring mass system, torsional oscillator; Spring mass system - free, damped, forced oscillations and resonance; Wave motion: Plane progressive wave, attenuation of waves, differential equation and solution of a plane progressive wave, phase velocity, superposition of waves and group velocity. (9)

OPTICS : Review of Image formation by lenses, combination of thin and thick lenses; Chromatic and spherical aberrations, methods to reduce aberrations; Interference- superposition principle, intensity distribution, condition for interference, coherent and non-coherent sources, classification of fringes, system for observing interference phenomena, engineering applications - interferometric displacement measurement; Diffraction - Fraunhofer diffraction for single slit and double slit, diffraction grating, resolving power of a grating; Image formation system -optical microscope. (9)

HEAT : Heat transfer modes: Convection, conduction and radiation; Specific heat capacity; Coefficient of linear thermal expansion - measurement of thermal expansion - optical lever and dilatometry methods; Thermal stresses in composite structures due to non-homogeneous thermal expansion - applications in bimetallic strip, expansion gaps and rollers in engineering structures; Thermal conductivity - differential equation of one dimensional heat flow - Searle's apparatus and Lee's disc apparatus for determination of thermal conductivity - applications to refrigerators and ovens. (9)

ELECTROMAGNETISM : Review of definitions of fundamental terms; Permeability; Forces due to currents; Uniform and non-uniform magnetic fields; Static and time-varying magnetic fields; Electromagnetic induction - expression for induced emf; Electric fields - permittivity and dielectric displacement; Gauss theorem; Maxwell's equations and interpretation of Maxwell's equations; Electromagnetic waves - propagation of electromagnetic waves through isotropic media. (9)

Total L: 45

TEXT BOOKS:

1. Richard Wolfson "Essential University Physics", Pearson Education., Singapore, 2016
2. Hugh D. Young, Roger A. Freedman, Lewis Ford .A "University Physics with Modern Physics", Pearson Education., India, 2008

REFERENCES:

1. Halliday D, Resnick R, Walker J "Fundamentals of Physics", Wiley Publications., 2013
2. Raymond A. Serway, John W, Jewett "Physics for Scientists and Engineers", Cengage Learning., 2017
3. Paul A Tipler, Geene Mosca "Physics for Scientists and Engineers", W.H.Freeman and Company., New york, 2007
4. Gaur R K, Gupta S L "Engineering Physics", Dhanpat Rai Publications., 2013

19A103 CHEMISTRY**3 0 0 3**

THERMODYNAMICS : Review of first law, variation of heat of reaction with temperature, adiabatic flame temperature. Joule Thomson effect and its significance- inversion temperature-liquefaction of gases. Second law- statements- entropy and spontaneity-free energy and spontaneity. Gibbs-Helmholtz equation. Concept of chemical potential-variation of chemical potential with T and P, Gibbs-Duhem equation- Clausius Clapeyron equation- concept of fugacity and activity. (9)

PHASE EQUILIBRIA : Definitions—one component system (water), two component systems-Cu-Ni and Pb-Ag systems-lever rule. Solubility of gas in liquids. Distribution law-principle of extraction—applications. Binary liquid systems-fractional distillation—azeotropic mixtures. (9)

KINETICS : Review of Integrated rate laws. Complex reactions- opposing, parallel and consecutive reactions- steady state approximation- branched chain reactions-mechanism and kinetics of combustion of hydrogen and hydrocarbons. (9)

SURFACE CHEMISTRY : Adsorption - Freundlich and Langmuir adsorption isotherms, application of BET isotherm (Derivation not required). Applications of adsorption- abatement of air and water pollution- automobile catalytic convertors. Surface active agents-surfactants, detergents, emulsifiers, properties- critical micellar concentration, contact angle, wetting and water repellency. Superhydrophobic surfaces. (9)

ELECTROCHEMISTRY : Electrode potential- emf series- standard and reference electrodes — SHE, calomel, Ag/AgCl. Nernst equation-galvanic and concentration cells-Ion selective electrodes- glass electrode-applications. Potentiometric and conductometric titrations. Applied Electrochemistry: electroplating, electropolishing, electrochemical machining, electrophoretic painting, anodization of aluminium. (9)

Total L: 45**TEXT BOOKS:**

1. Peter Atkins, Julio de Paula "Elements of Physical Chemistry", Oxford university press., UK, 2013 , 6th ed
2. B.R. Puri, L.R. Sharma, M.S. Pathania "Principles of Physical Chemistry", Vishal Publishing Company., India, 2017 , 47th ed

REFERENCES:

1. Donald A. McQuarrie, John D. Simon "Physical Chemistry: A Molecular Approach", University Science Books., USA, 1997 , 1st ed
2. Derek Pletcher, Frank C. Walsh "Industrial Electrochemistry", Chapman and Hall., London, 1990 , 2nd ed
3. J. Rajaram, J. C. Kuriakose "Thermodynamics for Students of Chemistry", Shobanlal Nagin Chand Company., India, 1986 , 1st ed

19A104 ENGINEERING MATERIALS**3 0 0 3**

INTRODUCTION : Engineering Materials and Metallurgy - Fundamental of metallurgy - Phase diagram - binary isomorphous systems — Iron - Carbon phase diagram, development of microstructures in iron - carbon alloys. Isothermal transformation diagrams and continuous cooling transformation diagrams (9)

FERROUS AND NON FERROUS MATERIALS : Steels and cast irons: composition, structure and properties of steels- carbon steels, low alloy steels stainless steels, tool steels. Composition, structure and properties of cast irons - grey iron, ductile iron, white iron and malleable iron, commercial grades of materials. Non - ferrous alloys: composition, structure and properties of non - ferrous alloys - copper and its alloys, aluminum and its alloys, magnesium and its alloys, nickel and its alloys, titanium and its alloys and commercial grades of materials (9)

STRENGTHENING OF MATERIALS : Principle – Precipitation hardening, solution hardening, strengthening by grain refinement. - Heat treatment — Process annealing, stress relief annealing, full annealing, normalising, spheroidising, hardening, tempering, austempering, martempering, - surface hardening – carburising, cyaniding, flame hardening, induction hardening, nitriding. - Hardenability – concepts, assessment – the Jominy end quench test. (9)

CHARACTERISATION AND EVALUATION OF MATERIALS : Material Characterization techniques — Optical, physical, chemical and mechanical. Destructive testing and evaluation of materials — Hardness testing — Rockwell hardness test, Brinell hardness test, Knoop and Vickers hardness tests. Impact testing - Charpy and Izod tests. - Non destructive testing and evaluation of materials — liquid penetrant test, magnetic particle test, - radiography test (X ray and gamma ray)

and ultrasonic test.

(9)

ADVANCED MATERIALS : Automotive Light weight materials, Composites, Polymers, Rubbers, Nano structured materials, Smart materials, Elastomers, Plastics, MEMS and NEMS materials. - Materials for Intelligent systems and other safety systems. Materials for green vehicle technology electric, electric and hybrid, solar powered and fuel cell powered vehicles.

(9)

Total L:45

TEXT BOOKS:

1. Donald R. Askeland "The Science and Engineering of Materials", Cengage Learning India., India, 2012
2. William D. Callister Jr "Materials Science and Engineering an Introduction", John Wiley and Sons Inc., 2010 , 8

REFERENCES:

1. William F. Smith "Foundations of Materials Science and Engineering", McGraw- Hill Publishing Co., 2009
2. George E. Dieter "Mechanical Metallurgy", McGraw-Hill Co., 2017 ,3
3. John Brown "Fosco Ferrous and Non Ferrous Foundryman's Handbook", Butterworth-Heinemann., 2000
4. American Society for Metals "ASM Handbook - Volume 1- 4, 8 and 17",ASM., 1998

19G105 ENGLISH LANGUAGE PROFICIENCY

2 1 0 3

LEARNING LANGUAGE THROUGH STANDARD LITERARY AND GENERAL TEXTS : Integrated tasks focusing on language skills ; Training based on Text based vocabulary, tone, register and Syntax features (12 + 0)

GRAMMAR IN CONTEXT : Word Order ; Subject Verb Concord ; Style features - Tenses, Conditionals, Prepositions, Active and Passive Voice, Modals, Cloze and Spotting Error exercises (10 + 0)

GUIDELINES FOR WRITTEN COMMUNICATION : Principles of clear writing, Paragraph writing, Essay writing, Emphasis Techniques, Summarizing and Paraphrasing, Analytical writing (8 + 0)

FOCUS ON SPOKEN ENGLISH : Task — based activities: Graded levels of difficulty and with focus on language functions - Level 1: Self — expression — Greetings in Conversation, Hobbies, Special interests, Daily routine - Level 2: General Awareness — Expression of Concepts, Opinions, Social Issues, Description of a process / picture/chart, news presentation / review -Level 3: Advanced Skills — Making Short Speeches and Participating in Role Plays (0 + 10)

LISTENING ACTIVITY: Task based activities using Language Laboratory (0 + 5)

Total L: 30 +T: 15 = 45

TEXT BOOKS:

1. Faculty Incharge "Course Material on "English Language Proficiency", PSG College of Technology., Coimbatore, 2019

REFERENCES:

1. Jill Singleton "Writers at Work: The Paragraph", Cambridge University Press., New York, 2012
2. Simon Haines, Mark Nettle and Martin Hewings "Advanced Grammar In Use", Cambridge University Press., New Delhi, 2008
3. Anne Laws "Writing Skills", Orient Black Swan., Hyderabad, 2011
4. Sinha DK "Specimens of English Prose", Orient Black Swan., Hyderabad, 2012

19A110 ENGINEERING GRAPHICS

0 0 4 2

INTRODUCTION :

Introduction to Engineering Drawing. Bureau of Indian Standards (BIS). BIS Engineering drawing practices SP 46:2003 — layout and folding of drawing sheets, Lines, Lettering and Dimensioning. Geometric Constructions. (12)

ORTHOGRAPHIC , ISOMETRIC AND PERSPECTIVE PROJECTION :

Theory of projection - Principle of orthographic projection— First angle, third angle projections. Profile planes and side views. Multiple views of 3D objects- Principles of perspective projection, methods, projection of solids. Isometric view of simple engineering components. (12)

PROJECTION OF SOLID GEOMETRY :

Projection of points, lines, planes and Solids. (12)

SECTION OF SOLIDS :

Sections of regular solids, types of sections, BIS conventions, selection of sectional views. Sectional views of simple engineering components. (12)

DEVELOPMENT OF SURFACES :

Development of lateral surfaces of regular solids, truncated solids and simple engineering sheet metal components. (12)

Total P:60

TEXT BOOKS:

1. Venugopal K. and Prabhu Raja V "Engineering Graphics", New Age International Publishers., 2017
2. Dhananjay A.Jolhe "Engineering Drawing", Tata McGraw Hill., 2017
3. John K.C "Engineering Graphics", PHI., 2019

REFERENCES:

1. Bureau of Indian Standards "Engineering Drawing Practices for Schools and Colleges SP 46-2003", BIS., New Delhi, 2003
2. Luzadder W. J "Fundamentals of Engineering Drawing", Prentice Hall Book Co., New York, 1998

19A111 BASIC SCIENCES LABORATORY

0 0 4 2

PHYSICS (ANY EIGHT EXPERIMENTS) :

1. Determination of Young's Modulus of a wooden bar — Cantilever method
2. Determination of rigidity modulus of a given material using Torsion pendulum
3. Determination of thermal conductivity of bad conductor using Lee's Disc method
4. Determination of fibre thickness — air wedge method
5. Determination of wavelength of mercury spectrum using transmission grating
6. Measurement of vibration frequency of electrically maintained tuning fork using Melde's apparatus
7. Determination of Hysteresis loss of a ferromagnetic material
8. Determination of thermal conductivity of a metallic material using Wiedemann — Franz law
9. Determination of capacitance using LCR bridge
10. Determination of lattice constant using X-ray powder photograph (30)

CHEMISTRY (ANY EIGHT EXPERIMENTS) :

1. Determination of rate constant of hydrolysis of an ester
2. Construction of eutectic phase diagram
3. Conductometric estimation of acid strength of a pickling bath
4. Electroplating of nickel and copper and determination of cathode efficiency
5. Anodizing of aluminium and determination of thickness of anodized film
6. Determination of kinematic viscosity of lubricating oil using Redwood viscometer
7. Determination of flash and fire point of lubricating oil
8. Analysis of solid fuel by proximate analysis of coal
9. Mechanism of galvanic corrosion—Determination of corrosion rate by corrosion current measurement
10. Estimation of hardness of water by EDTA method (30)

Total P: 60

REFERENCES:

1. Department of Chemistry "Chemistry Laboratory Manual", .., 2019
2. Department of Physics "Physics Practicals", .., 2019
3. Wilson J. D., Hernandez C. A. "Physics Laboratory Experiments", Houghton Mifflin Company., New York, 2005

19A112 ENGINEERING PRACTICES LAB

0 0 2 1

FOUNDRY :

Tools, preparation of moulding sand, patterns, cores, foundry exercises (5)

WELDING :

Metal arc welding tools and equipment, exercises by Arc welding Processes (5)

FITTING :

Tools, operations, exercises — Make "T" Joint and "L" Joint, types of joints (5)

CARPENTRY :

Tools, carpentry process, carpentry exercises, types of joints (5)

PLUMBING :

external thread cutting and joining (5)

SHEET METAL WORK& SOLDERING :

Tools, operations, exercises — Make a Rectangular Tray in Galvanized Iron sheet (5)

Total P: 30

REFERENCES:

Laboratory Manual Prepared by the Department

19IP15 INDUCTION PROGRAMME

0 0 0 0

As per AICTE guidelines

SEMESTER - 2

19A201 COMPLEX VARIABLES AND TRANSFORMS

3 1 0 4

COMPLEX DIFFERENTIATION : Derivative, analytic function, Cauchy-Riemann equations, Laplace's equation, linear fractional transformations. (9 + 3)

COMPLEX INTEGRATION : Cauchy's integral theorem, Cauchy's integral formula, Laurent series, singularities and zeros, residue integration method (Residue integration of complex integrals only). (9 + 3)

LAPLACE TRANSFORMS : Laplace transform, linearity, first shifting theorem, transforms of derivatives and integrals, ODEs, unit step function, second shifting theorem, Dirac's delta function, periodic functions. (9 + 3)

FOURIER SERIES AND FOURIER TRANSFORMS : Fourier series — arbitrary period, even and odd functions, half range expansions. Fourier transforms, Fourier cosine and sine transforms. (9 + 3)

PARTIAL DIFFERENTIAL EQUATIONS : Basic concepts of PDEs, wave equation, heat equation, steady state two-dimensional heat problems, solution by separating variables and Fourier series. (9 + 3)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. Erwin Kreyszig "Advanced Engineering Mathematics", Wiley India Pvt Ltd., New Delhi, 2015
2. Wylie C R and Barret L C "Advanced Engineering Mathematics", Tata McGraw-Hill., New Delhi, 2019

REFERENCES:

1. Dennis G Zill and Patrick D Shanahan "A First Course in Complex Analysis with Applications", Jones and Bartlett Pvt Ltd., New Delhi, 2015
2. Mathews J H and Howell R W "Analysis for Mathematics and Engineering", Narosa Publishing House., New Delhi, 2012
3. Peter V O Neil "Advanced Engineering Mathematics", Cengage., New Delhi, 2016
4. Dennis G Zill "Advanced Engineering Mathematics", Jones & Bartlett Pvt Ltd., New Delhi, 2017

19A202 MATERIALS SCIENCE

2 0 0 2

CRYSTAL STRUCTURE : Atomic bonding in solids, crystalline state of solids, unit cells and space lattices, crystal structures, crystal planes and directions, Miller Indices, coordination number, atomic packing factor of simple cubic, BCC, FCC and HCP structures; Crystal imperfections — point, line, surface and volume imperfections. (7)

FUNCTIONAL CERAMICS : Sintering, hot isostatic pressing, sol-gel process, chemical vapour deposition, injection moulding; Dielectric properties — dielectric constant, dielectric strength and dielectric loss factor; Piezoelectric and pyroelectric properties; Mechanical properties — fracture toughness, strength of ceramics; Ceramic cutting tools; Thermal properties – thermal stress, thermal shock and thermal conductivity. (8)

POLYMERS : Classification of polymers; Structure-property relationships in thermoplastics - degree of polymerization, effect of side groups, crystallization and deformation; Effect of temperature on thermoplastics; Crystallinity in polymers; Mechanical properties - elastic and plastic behavior, creep and stress relaxation, impact and deformation; Thermosetting polymers. (7)

COMPOSITES : Connectivity, reinforcement, fibres — glass fibre, aramid fibre, carbon fibre, properties and fabrication; Particulate and whisker reinforcements; Metal matrix - aluminium, titanium and magnesium alloys, MMC processing — solid and liquid state processes, Al / ceramic reinforcements - properties; Ceramic matrix - hot pressing, Al₂O₃ / SiC whisker - properties; Polymer matrix - carbon– epoxy and boron–epoxy composites; Volume fraction and weight fraction, applications - aircraft engineering, space, wind turbines, sports equipment and automobiles. (8)

Total L: 30

TEXT BOOKS:

1. Michel W Barsoum "Fundamentals of Ceramics", McGraw Hill Book Co., 2000
2. Mathews F.L, Rawlings "Composite Materials and Science", Woodhead Publishing Ltd., 2002

REFERENCES:

1. James F Shackelford "Introduction to Materials Science for Engineers", Pearson Prentice Hall., 2009
2. Kingery W.D, Bowen H.K, Uhlmann D.R "Introduction to Ceramics", John Wiley and Sons., 2004
3. Krishan K Chawla "Composite Materials, Science and Engineering", Springer-Verlag., 2013
4. Raghavan V "Materials Science and Engineering: A First Course", Prentice Hall of India Pvt. Ltd., 2015

19A203 CHEMISTRY OF ENGINEERING MATERIALS**2 0 0 2**

FUELS AND COMBUSTION : Petroleum - refining, cracking and polymerisation- petrol and diesel knocking-octane and cetane rating of fuels-reforming of gasoline. Coal- carbonization- coke manufacture-Otto-Hoffmann method. Synthetic petrol- Bergius process. Combustion of fuel- calorific value and theoretical air calculations. (6)

BATTERIES AND FUEL CELLS : Batteries- characteristics-construction and working of Lechlanche, lead-acid, nickel-cadmium and lithium ion batteries- supercapacitors. Batteries for automobiles, satellites, torpedos, computer standby supplies. Fuel cell- theory, working principle and applications of proton exchange membrane, direct methanol fuel cells and solid oxide fuel cells. (6)

CORROSION AND PROTECTIVE COATINGS : Forms of corrosion and their mechanism- galvanic, atmospheric, pitting, crevice and stress corrosion. Corrosion protection by design, cathodic protection, protective coatings, corrosion inhibitors - mention of types and applications. (6)

MACROMOLECULES : Classification, molecular weight - M_n and M_w . Mechanism of polymerization- structure related to thermal, electrical and mechanical properties of polymers. Compounding of plastics, Moulding of plastics- compression, injection, extrusion and blow moulding techniques. Rubber — structure, vulcanization- fibre and carbon reinforced plastics, types of adhesives and sealants. (6)

MISCELLANEOUS MATERIALS : Lubricants-classification- properties, mechanism of lubrication- additives and improvers. Solid lubricants (graphite and MoS₂). Abrasives: Natural abrasives (diamond and corundum)-synthetic abrasives (silicon carbide and boron carbide). Refractories- characteristics — classification —alumina, magnesite and zirconia bricks-applications. Boiler feed water- requisites -estimation of hardness-demineralization process. Nanomaterials and their applications-Graphene, CNT, ferrofluids. (6)

Total L: 30**TEXT BOOKS:**

1. Shashi Chawla "A Text Book of Engineering Chemistry", Dhanpat Rai and Company., New Delhi, 2005 , 1st ed
2. SS Dara, SS Umare "A Textbook of Engineering Chemistry", S Chand and Company., India, 2010 , 20th ed

REFERENCES:

1. Sharma B. K "Engineering Chemistry", Krishna Prakashan Media (P) Ltd., Meerut, 2005 , 1sted
2. MaryJane Shultz "Engineering Chemistry", Cengage learning., USA, 2009 , 1st ed
3. P. C. Jain, M. Jain "Engineering Chemistry", Dhanpat Rai Publishing Company., New Delhi, 2005 , 1sted

19A204 ENGINEERING MECHANICS**3 1 0 4**

STATICS : Resultant of concurrent forces - Force on a particle - resultant of concurrent forces - resolution of force - equilibrium of a particle - free body diagram - force in space - equilibrium of a particle in space - transmissibility - moment of a force - resolution of a force into a force and a couple - reactions at supports - equilibrium of a two and three force bodies - Simple trusses - method of joints (12)

FRICTION : Laws of dry friction - angles of friction - coefficient of static and kinetic friction - wedge friction – rolling resistance - belt friction (9)

CENTROID, CENTRE OF GRAVITY AND MOMENT OF INERTIA : Centroids of areas - composite areas - center of gravity - determination of moment of inertia - polar moment of inertia - radius of gyration - mass moment of inertia of simple solids (9)

KINEMATICS AND KINETICS : Equation of motion - rectilinear and rotary motion - Energy - potential energy – kinetic energy - conservation of energy - work done by a force - work energy method (9)

IMPULSE AND MOMENTUM : Impulse - Momentum principle - Direct central impact - oblique central impact- impact of a moving car on the spring board. (6)

Total L: 45**TEXT BOOKS:**

1. Beer F P and Johnson E R "Vector Mechanics for Engineers, Statics and Dynamics", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2010
2. Rajasekaran S and Sankarasubramanian G "Engineering Mechanics-Statics and Dynamics", Vikas Publishing House Pvt. Ltd., New Delhi, 2006

REFERENCES:

1. Bansal R K "Engineering Mechanics", Laxmi Publications Pvt. Ltd., New Delhi, 2006
2. Bhavikatti S S "Engineering Mechanics", New Age International Pvt. Ltd., New Delhi, 2003
3. Young D H and Timashenko S "Engineering Mechanics", Tata Mcgraw-Hill., 2006
4. Jivan Khachane, Ruchi Shrivastava "Engineering Mechanics: Statics and Dynamics", ANE Books., 2006

19A205 MANUFACTURING PROCESSES**3 0 0 3**

CASTING : Steps involved in making a casting — Advantage of casting and its applications. Patterns and Pattern making — Types of patterns — Materials used for patterns - core and core making - casting design considerations. Casting processes - Sand casting - centrifugal die casting - investment casting - lost foam casting - gravity die - squeeze casting - shell casting - Methods of Melting: Crucible melting furnace - cupola furnace (9)

WELDING : Classification of welding processes. Principles of Oxy-acetylene gas welding. A.C metal-arc welding - resistance welding - submerged arc welding - tungsten inert gas welding - metal inert gas welding - plasma arc welding - thermit welding - electron beam welding - laser beam welding - defects in welding - soldering and brazing. (9)

FORMING AND SHAPING OF PLASTICS : Stamping, forming and other cold working processes - Blanking and piercing — Bending and forming — Rolling - Drawing and its types — wire drawing and Tube drawing. Types of presses and press tools. Basic extrusion processes and its characteristics. - Forging processes - Principles of forging tools and dies - Types of forging — Open, closed - Flash less forging, roll forging - Moulding of Thermoplastics — Working principles and typical applications of - Injection moulding (9)

MACHINING : General principles (with schematic diagrams only) of working and commonly performed operations in the following machines: Lathe - Shaper - Planer - Horizontal milling machine-Universal drilling machine - cylindrical grinding machine - Capstan and Turret lathe. Basics of CNC machines. - General principles and applications of the following processes: Abrasive jet machining - Ultrasonic machining - Electric discharge machining - Electro chemical machining - Plasma arc machining - Electron beam machining and laser beam machining. (9)

POWDER METALLURGY : Production of metal powders - mixing and blending - compacting - sintering and secondary operations. Application of Powder Metallurgy in Automobile fields (9)

Total L: 45**Text Books:**

1. Serope Kalpakjian, Steven R Schmid "Manufacturing Engineering And Technology", Pearson., Noida, 2014
2. John A Schey "Introduction To Manufacturing Processes", Mcgraw-Hill, Inc., Newyork, 2000 , Third

References:

1. Ricard W Heine, Carl R Loper, Phillip C Rosenthal "Principles Of Metal Casting", Tata Mcgraw-Hill., New Delhi, 1997
2. Banga T R, Tahil Manghnani, Agarwal R L "Foundry Engineering", Khanna Book Publishers., New Delhi, 1987
3. Rao P N "Manufacturing Technology: Foundry Technology And Welding", Tata Mcgraw- Hill., New Delhi, 2007 ,Second

19A210 C PROGRAMMING LABORATORY**0 0 4 2**

1. Working with RAPTOR Tool — Flowchart Interpreter
2. Simple programs to understand Operators and expressions.
3. Decision making Statements :simple if, if..else, nested if .. else,elseifladder, switch case
4. Loops : while , do..while, for
5. Implementation of one dimensional array
6. Implementation of two dimensional array
7. Working with Strings
8. Functions
9. Recursive functions
10. Structures: Arrays and Structures,Nested Structures
11. Structures and functions
12. Implementation of pointer and pointer arithmetic
13. Types of pointer:const pointer, pointer to a constant, void pointer, null pointer

Total P: 60**REFERENCES:**

1. Deitel H. M. and Deitel P. J "C: How To Program", Prentice Hall of India., New Delhi, 2015
2. Ajay Mittal "Programming in C - A Practical approach", Pearson., New Delhi, 2010
3. Gottfried B "Programming with C", McGraw Hill Education., New Delhi, 2018
4. Herbert Schildt "C: The Complete Reference", McGraw Hill., New Delhi, 2017

19A212 MANUFACTURING PRACTICE LAB

0 0 2 1

LATHE :

1. Study of construction features and manufacturing methods in machine tools.
2. LATHE- Facing Plain turning
3. LATHE-Facing chamfering and step turning
4. LATHE- Taper Turning and Knurling
5. LATHE-Step Turning and thread cutting
6. LATHE-Facing and Drilling by using Tailstock. (15)

SPECIAL MACHINE :

1. Shaper-Rectangular Block Machining.
2. Radial Drilling Machine- Drilling, Counter sinking, Counter Boring and Tapping.
3. Milling-Pocket milling and slot milling
4. Gear hobbling- Spur gear machining from gear blank
5. Slotting- Machining an internal spline. (15)

Total P: 30

REFERENCES:

Laboratory Manual Prepared by the Department

19A213 INTERNSHIP

0 0 0 2

TRAINING IN CAD PACKAGE: Solid modelling and assembly practice, Extraction of 2D view from 3D modelling, Coloring and shading of 3D models, surface modelling.

AUTOMOTIVE INDUSTRY ORIENTED ACTIVITIES: Factory visit to study the layout, organization structure, and various departments Study of construction, working of the following machine tools and processes · Broaching machine · Boring machine · Grinding machine · Electric discharge machining Study of manufacturing processes. · Pressure die casting · Sand Casting · Rapid prototyping techniques Study of assembly processes · Pump assembly · Motor assembly · Lathe assembly

REPORT PREPARATION: Preparation of a comprehensive report by the students for the industry oriented activities that will be assessed by a committee of faculty members.

REFERENCES:

1. Prepared by CAD CAM Centre "Practice of Machine Drawing using CAD Software", PSG College of Technology,, Coimbatore, 2018 ,NA
2. PC Sharma "Text Book of Production Technology (Manufacturing Processes)", S.Chand & Company PVT., New Delhi, 2014 ,NA

SEMESTER - 3

19A301 NUMERICAL METHODS

2 1 0 3

SYSTEM OF LINEAR EQUATIONS, EIGENVALUES AND EIGENVECTORS : Errors - approximations and round-off errors - truncation errors - system of linear equations-Gauss-elimination method, Crout's method, Gauss-Seidel method, eigen values and eigenvectors - power method. (6 + 3)

NONLINEAR EQUATIONS : False - position method, Newton-Raphson method, modified Newton-Raphson method, Bairstow's method. (6 + 3)

INTERPOLATION, DIFFERENTIATION AND INTEGRATION : Lagrange interpolating polynomials, equally spaced data-Newton's forward and backward interpolating polynomials, numerical differentiation – evenly spaced data, numerical integration- Newton-Cotes formulae, Trapezoidal rule, Simpson's 1/3 rule. (6 + 3)

NUMERICAL SOLUTION TO ORDINARY DIFFERENTIAL EQUATIONS : Taylor-series method, Euler method, 4th order Runge-Kutta method, multi step method - Milne method. (6 + 3)

NUMERICAL SOLUTION TO PARTIAL DIFFERENTIAL EQUATIONS : Finite difference: elliptic equations - Laplace equation, Poisson equation – Liebmann method, parabolic equations – heat conduction equation – Crank Nicolson's method, hyperbolic equations – vibrating string. (6 + 3)

Total L: 30 +T: 15 = 45

TEXT BOOKS:

1. Steven C Chapra and Raymond P Canale , "Numerical Methods for Engineers", Tata McGraw Hill, New Delhi, 2017.
2. Curtis F Gerald and Patrick O Wheatly , "Applied Numerical Analysis", Pearson, New Delhi, 2017.

REFERENCES:

1. Richard L Burden and Douglas J Faires , "Numerical Analysis", Thomas Learning, New York, 2017.
2. G. Miller , "Numerical Analysis for Engineers and Scientists", Cambridge University Press, UK, 2014.
3. Amos Gilat and Vish Subramaniam , "Numerical Methods for Engineers and Scientists", Wiley India, New Delhi, 2014.
4. Ward Cheney and David Kincaid , "Numerical Mathematics and Computing", Cengage learning, USA, 2018.

19A302 STRENGTH OF MATERIALS**3 1 0 4**

STRESSES AND STRAINS : Stress, strain and strain energy due to axial force sudden load and impact load - Poisson's ratio - volumetric strain - shear stress - shear strain - thin cylindrical and spherical shells under internal pressure - thermal stresses - principal stresses and planes - Mohr's circle for plane stress. (12 + 4)

BENDING MOMENT AND SHEAR FORCE : Shear force and bending moment diagrams for cantilever, simply supported and overhanging beams under concentrated loads, uniformly distributed loads, uniformly varying loads, concentrated moments - maximum bending moment and point of contra flexure. (9 + 3)

FLEXURE IN BEAMS AND TORSION IN SHAFTS : Theory of simple bending and assumptions - flexure equation - theory of torsion and assumptions - torsion equation - power transmitted by shafts. (9 + 3)

DEFLECTION OF DETERMINATE BEAMS : Governing differential equation - Macaulay's method - moment area method - application to simple problems (cantilever beams and simply supported beams only). (9 + 3)

COLUMNS AND STRUTS : Behaviour of axially loaded short and long column members - different end conditions - buckling load - Euler's theory - Rankine's formula. (6 + 2)

Total L: 45 +T: 15 = 60**TEXT BOOKS:**

1. Ferdinand P. Beer, E. Russell Johnston Jr, John T. Dewolf, David F. Mazurek , "Mechanics of Materials", 6th Edition, McGraw-Hill, New York, 2012.
2. Andrew Pytel, Ferdinand Leon Singer , "Strength of Materials", 4th Edition, Addison-Wesley, Tokyo, 2011

REFERENCES:

1. RK Bansal , "A Textbook of Strength of Materials", Laxmi Publications (P) Ltd, 2015.
2. Jindal UC , "A Textbook of Strength of Materials", Pearson, 2012.

19A303 KINEMATICS OF MACHINERY**3 1 0 4**

BASICS OF MECHANISMS : Terminology and definitions - degree of freedom - mobility - Grashoff's law - Kinematic inversions of four bar chain & slider crank chain - Mechanical advantage - Transmission angle - Description of common mechanisms - applications of mechanisms - Introduction to 4-bar spatial mechanisms. (9 + 3)

KINEMATIC ANALYSIS : Displacement, velocity and acceleration analysis in four bar and slider crank mechanisms - graphical method - velocity and acceleration polygons - Kinematic analysis - analytical method - vector approach. (9 + 3)

KINEMATICS OF CAM : Classifications - displacement diagrams - parabolic, uniform velocity, simple harmonic paths - Layout of plate cam profiles for different types of followers - knife edged, roller, mushroom, flat type - Derivatives of follower motion - pressure angle - undercutting. (9 + 3)

GEARS : Spur gear terminology and definitions - Fundamental law of toothed gearing and tooth forms - Interchangeable gears, gear tooth action - path of contact, arc of contact, number of pair of teeth in contact, interference and undercutting - Helical, bevel, worm, rack and pinion gears (basics only) - Gear trains - epicyclic gear trains - analysis of epicyclic gear train - relative velocity and torque - automotive differential gear trains. (9 + 3)

GOVERNORS & GYROSCOPE : Governors - Types - Centrifugal governors - Characteristics - Effect of friction - Controlling force - Gyroscopic couple and its effect in ship, car, motorcycle, aeroplanes - Gyroscopic stabilization. (9 + 3)

Total L: 45 +T: 15 = 60**TEXT BOOKS:**

1. John J. Uicker Jr., Gordon R. Pennock, Joseph E. Shigley , "Theory of Machines and Mechanisms", 5th Edition, Oxford University Press, 2016.
2. S S Rattan , "Theory of Machines", 4th Edition, McGraw Hill Education, 2017.

REFERENCES:

1. Thomas Bevan , "Theory of Machines", 3rd Edition, CBS Publishers & Distributors, 2005.
2. J S Rao, R V Dukkipati , "Mechanism and Machine Theory", 2nd Edition, New Age International Publisher, 1992.
3. C S Sharma, Kamlesh Purohit , "Theory of Mechanisms and Machines", 1st Edition, Prentice hall of india private limited, New Delhi, 2006.
4. Sadhu Singh , "Theory of Machines: Kinematics and Dynamics", 3rd Edition, Pearson Education India, 2011.

19A304 ENGINEERING THERMODYNAMICS

3 1 0 4

BASIC CONCEPTS OF THERMODYNAMICS : System and their behavior, properties of a system, state and equilibrium, process and cycles, pure substance and property diagram for phase change process, zeroth law and first law of thermodynamics and their application - energy and energy transfer - heat and work interactions, general energy equation and applications to thermal equipment's - turbines, compressors, nozzle, diffuser etc. First law - application on automobiles.

(9 + 3)

SECOND LAW OF THERMODYNAMICS : Statements - heat engines, heat pump and refrigerator - Energy conversion efficiency, reversible and irreversible process, Carnot cycle and theorem, Entropy - Clausius inequality, change of phases of entropy, Second law - application on IC Engine.

(9 + 3)

GAS POWER CYCLES : Basic consideration in the analysis of power cycles, Otto, Diesel and their performance analysis, Brayton cycle with regeneration, intercooling and reheating - performance analysis. Problem solving of Aircraft engine and race car engine.

(9 + 3)

VAPOUR POWER CYCLES : Rankine cycle with reheating and regeneration, open and closed feed water heating system - performance analysis and comparison with Carnot cycle. Problem solving of Steam power plants.

(9 + 3)

THERMODYNAMIC RELATION : Equations of state, Maxwell relations, Clapeyron equation, Gibbs equation, Joule - Thomson effect, general relation for real gases - internal energy, enthalpy, and entropy. P - V - T relation for gas mixture, generalized charts and conventional tables for thermodynamic properties.

(9 + 3)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. Cengel Y A, Boles M A, Mehmet Kanoglu , "Thermodynamics – An Engineering Approach", 9th Edition, Tata McGraw Hill Publishing Company, New York USA, 2019.
2. Moran M J, Shapiro H N, Boettner D D, Bailey M B , "Fundamentals of Engineering Thermodynamics", 8th Edition, Wiley and Sons, USA, 2014.

REFERENCES:

1. Stephen R Turns , "Thermodynamics - Concepts and applications", 1st Edition, Cambridge University Press, New York USA, 2006.
2. Nag P K , "Engineering Thermodynamics", Tata McGraw Hill Publishing Company, New Delhi, 2017.
3. Holman J P , "Thermodynamics", 5th Edition, McGraw Hill Book Company, New York, 2003.

19A305 AUTOMOTIVE CHASSIS

3 0 0 3

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

(9)

STEERING SYSTEM : Introduction - Functions and requirements - axles-live and dead axles - front axle and its types - stub axle and its types - steering mechanisms - arrangement of steering system - over steer and under steer - steering ratio calculation - steering gear box types - turning radius - center point steering - stub axle types - Wheel alignment - hydraulic power steering materials - types of bodies - features of body - body structural requirements - body structural elements - design for body bending - design for body torsion - design for crashworthiness - design for vibration - design for vehicle and styling integration - material selection and mass estimation in preliminary design.

(9)

SUSPENSION SYSTEM : Introduction - Functions - characteristics of good suspension system - suspension spring types - types of suspension system - dampers - types - telescopic shock absorbers - air suspension – hydro elastic suspension - hydro-pneumatic suspension system - active suspension system.

(9)

BRAKE SYSTEM : Introduction - principle - classifications - requirements - drum brake - disc brake - stopping distance calculations - weight transfer calculations - braking efficiency calculations - mechanical brake - hydraulic brakes - vacuum servo brakes - air brakes - air assisted hydraulic brakes - introduction to Anti-lock braking system - suspension system - active suspension system.

(9)

WHEELS AND TYRES : Basic construction of wheel - hub and tyres - tyre requirements - interchangeability - passenger car and commercial vehicle requirements - bias ply and radial ply tyres - tubeless tyres – wheel balancing - tyre inflation - tyre wear and tyre rotation - quick change wheels - special wheels - run flat tyre. (9)

Total L: 45

TEXT BOOKS:

1. David C Barton, John D Fieldhouse , "Automotive Chassis Engineering", 2nd Edition, Springer Publisher, 2013.
2. Jornsens Reimpell, Helmut Stoll, Jurgen Betzler , "The Automotive Chassis: Engineering Principles", 2nd Edition, Butterworth and Heinemann Publisher, 2012.

REFERENCES:

1. Herb Adams , "Chassis Engineering", 4th Edition, HP Books Publishers, 2013.
2. Bernhard Heißing, Metin Ersoy , "Chassis Handbook: Fundamentals, Driving Dynamics, Components, Mechatronics and Perspectives", 2nd Edition, Veeeg +Tiebuner Publishers, 2009.

190306 ECONOMICS FOR ENGINEERS

3 0 0 3

INTRODUCTION : Definition – Nature and Scope – Central Problems of an Economy – Positive and Normative Economics – Micro Economics and Macro Economics, Significance of Economics, Economic Assumptions. (9)

THEORY OF CONSUMER BEHAVIOR : Utility – Indifference Curve Analysis - Properties, Consumer's Budget Line - Demand Analysis: Demand Function and Law of Demand, Elasticity of Demand. Demand forecasting using Econometric Techniques. Supply – Factors Affecting Supply, Market Equilibrium Price, Consumer Surplus. (9)

PRODUCTION, COST AND REVENUE : Production Function, Total Product, Average Product and Marginal Product, Returns to Scale. Costs, Nature of Costs, Short-run and Long-run Cost Curves, Revenue concepts. (9)

MARKET STRUCTURE : Types of Markets - Perfect Competition – Characteristics – Imperfect Competition: Monopoly – Monopolistic Competition – Oligopoly and Duopoly - Price Discrimination and Product Differentiation under Different Markets – Price and Output Determination in Short run and Long run and profit maximization. (9)

PERFORMANCE OF AN ECONOMY (MACRO ECONOMICS) : Demand and Supply of Money – Quantity Theory of Money, Banking – Functions of Commercial Banks and Central Bank – Inflation – Causes – Control Measures – National Income – Concepts – Methods of Calculating National Income – Problems in Calculating National Income. (9)

Total L: 45

TEXT BOOKS:

1. Varian H.R. , "Intermediate Microeconomics", East–West Press, New Delhi, 2014.
2. Dewett.K.K, Navalur. M.H. , "Modern Economic Theory", S. Chand, New Delhi, 2015.

REFERENCES:

1. William A, McEachern, Simrit Kaur , "Micro ECON", Cengage Learning, Noida, 2013.
2. William A, McEachern, Indira A. , "Macro ECON", Cengage Learning, Noida, 2014.
3. Deepashree , "Principles of Economics", Ane Books Pvt Ltd, New Delhi, 2010.
4. Dwivedi , "Essentials of Business Economics", Vikas Publishing House Pvt Ltd, New Delhi, 2010.

19A310 STRENGTH OF MATERIALS LABORATORY

0 0 2 1

STRENGTH OF MATERIALS LABORATORY :

1. Tension test on metals.
2. Brinell hardness test on metals.
3. Vicker hardness test on metals.
4. Rockwell hardness test on metals.
5. Impact test on metals--Charpy/Izod impact tests.
6. Double Shear test on metals.
7. Compression and tension springs tests on helical springs.
8. Torsion test on beams.
9. Deflection test on beams.
10. Cupping test on metal sheets.

Total P: 30

REFERENCES:

1. Magesh Kannan V , "Lab manual prepared by Dept. of Auto. Engg.", PSG College of Technology, Coimbatore, 2019.

19A311 MACHINE DRAWING

MACHINE DRAWING CONVENTIONS :

1. Need for drawing conventions- introduction to BIS conventions
2. Conventional representation of material, common machine elements and parts such as screws, nuts, bolts, keys, gears, webs, ribs.
3. Parts not usually sectioned. Methods of dimensioning, general rules for sizes and placement of dimensions for holes, centres, curved and tapered features.
4. Limits, Fits–Tolerancing of individual dimensions–Specification of Fits–Preparation of production drawings and reading of part and assembly drawings, basic principles of geometric dimensioning and tolerancing.
5. Title boxes, their size, location and details-common abbreviations and their liberal usage.

DRAWING OF MACHINE ELEMENTS AND SIMPLE PARTS :

1. Selection of Views, additional views for the following machine elements and parts with drawing proportions
2. Popular forms of Screw threads, bolts, nuts, stud bolts, tap bolts, set screws, Keys
3. Cotter joints and knuckle joint, Riveted joints for plates, flanged and protected flanged joint.
4. Shaft coupling, spigot and socket pipe joint.
5. Journal and foot step bearings

ASSEMBLY DRAWINGS :

1. Drawings of assembled views for the part drawings of the following.
2. Engine parts- stuffing boxes, cross heads, Petrol Engine.
3. Engine parts- connecting rod, piston assembly.
4. Other machine parts- Screw jack, Machine Vice, single tool post.
5. Valves: Steam stop valve, feed check valve. Non-return valve

Total P: 60

TEXT BOOKS:

1. Gopalakrishna K R , "Machine Drawing", Subhas Stores, Bangalore, 2013.
2. Narayana K L, Kannaiah P, Venkata Reddy K , "Machine Drawing", New Age International, New Delhi, 2012.

REFERENCES:

1. John K C , ""Machine Drawing"", PHI Learning, Delhi, 2009.
2. Faculty of Mechanical Engineering, PSG College of Technology , ""Design Data Book"", Kalaikathir Achchagam, Coimbatore, 2012.
3. ASME Y 14.5M-1994, 2005. , ""Dimensioning and Tolerancing"", ASME, New York, 2005.
4. BIS, "SP:46-2003 , ""Engineering Drawing Practice for Schools and Colleges"", New Delhi, 2003.

19K312 ENVIRONMENTAL SCIENCE

2000

INTRODUCTION TO ENVIRONMENT : Environment - Definition, scope and importance. Types and composition of atmosphere – particles, ions and radicals. Ozone layer- significance, formation and depletion. Ecosystems- Structure and functions, components, energy flow, food chains, food web, Biodiversity-levels, values and threats – India as a mega-diversity nation – hotspots of biodiversity – endangered and endemic species of India – conservation of biodiversity. (6)

ENERGY RESOURCES : Introduction – National and International status- exploitation - sustainable strategies- Fossil fuels-classification, composition, physico-chemical characteristics and energy content of coal, petroleum and natural gas; solar energy - introduction, harnessing strategies. Wind energy - availability, wind power plants, wind energy conversion systems, site characteristics, and types of wind turbines. Supporting renewable energy resources - tidal –geothermal -hydroelectric. (6)

ENVIRONMENTAL POLLUTION : Definition – Sources, causes, impacts and control measures of (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards (h) RF hazards - Role of an individual in prevention of pollution. **DISASTER MANAGEMENT:** Floods, earthquake, cyclone and landslides – Case studies, consequences and rescue measures. (6)

WASTE MANAGEMENT : Wastewater - Characteristics of domestic and industrial wastewater - COD and BOD – Various stages of treatment – primary, secondary, tertiary treatment- Biological and advanced oxidation processes. Solid waste management – Characteristics of municipal solid waste(MSW), biomedical, automobile and e-wastes and their management – landfills, incineration, pyrolysis, gasification and composting. (6)

SOCIAL ISSUES AND THE ENVIRONMENT : Environmentally Sustainable work practices- Rain water harvesting – Role of non-governmental organizations. Human ethics and rights- impact on environment and human health – role of information technology on environment and human kind. Green IT policies, Process of EIA - ISO 14000. Legislation- Environment protection act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife

protection act – Forest conservation act.

(6)

Total L: 30

TEXT BOOKS:

1. Gilbert M. Masters , "Introduction to Environmental Engineering and Science", Pearson Education, New Delhi, 2011.
2. De A K , "Environmental Chemistry", New Age International (P) Ltd, New Delhi, 2006.

REFERENCES:

1. Benny Joseph , "Environmental Science and Engineering", Tata McGraw-Hill, New Delhi, 2006.
2. KoteswaraRao MVR , "Energy Resources: Conventional & Non-Conventional", BSP Publications, New Delhi, 2006.
3. Deswal S and Deswal A , "A Basic Course in Environmental Studies", Dhanpat Rai and Co, New Delhi, 2004.

SEMESTER - 4

19A401 PROBABILITY AND STATISTICS

2 1 0 3

PROBABILITY AND DISCRETE RANDOM VARIABLES : Probability, axiomatic approach to probability, Baye's theorem , discrete random variables, probability distributions and probability mass functions, cumulative distribution functions, mean and variance, binomial, Poisson and geometric distributions. (6 + 3)

CONTINUOUS RANDOM VARIABLES : Continuous random variables, probability distributions and probability density functions, cumulative distribution functions, mean and variance, uniform, exponential, and normal distributions. (6 + 3)

JOINT PROBABILITY DISTRIBUTIONS : Two dimensional discrete and continuous random variables, marginal and conditional probability distributions, independence, covariance, correlation and linear regression. (6 + 3)

STATISTICAL INFERENCE : Point estimation - interval estimation – testing of hypotheses for means – large, small samples and matched pairs tests – testing of hypotheses for proportions, chi square test for goodness of fit and independence of attributes. (6 + 3)

VARIANCE TESTS AND ANALYSIS OF VARIANCE : Testing of Hypotheses for variances - analysis of variance - completely randomized design, randomized block design. (6 + 3)

Total L: 30 +T: 15 = 45

TEXT BOOKS:

1. Douglas C. Montgomery and George C. Runger , "Applied Statistics and Probability for Engineers", Wiley India, New Delhi, 2018.
2. Richard A. Johnson , "Miller & Freund's, Probability and Statistics for Engineers", Prentice Hall, New Delhi, 2017.

REFERENCES:

1. Jay L. Devore , "Probability and Statistics for Engineering and the Sciences", Brooks/Cole, USA, 2015.
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye , "Probability & Statistics for Engineers & Scientists", Pearson, New Delhi, 2016.
3. Robert V. Hogg, Elliot Tanis and Dale Zimmerman, "Probability and Statistical Inference", Pearson Education, USA, 2014.
4. Sheldon M Ross , "Introduction to Probability and Statistics for Engineers and Scientists", Academic press, USA, 2014.

19A402 FLUID MECHANICS AND MACHINERY

2 1 0 3

FLUID PROPERTIES : Pressure and temperature measurement, specific gravity and weight, viscosity, capillarity and surface tension, compressibility, vapor pressure and gas laws, Conservation of laws - mass, momentum and energy, continuum hypothesis - Newton's viscosity law - Newtonian Vs Non - Newtonian Fluids – Analysis and problem solving. (6 + 3)

FLUID STATICS : Pressure in fluids at rest - hydrostatic force on submerged surfaces, Buoyancy and stability, Stream function and vortices, potential function, types of flow and significance, Dimensional analysis, significant dimensionless groups, flow similarity and model studies, Problem solving of hydrostatics and model analysis. (6 + 3)

FLUID DYNAMICS : Motion of a fluid particle – Fluid deformation – Differential analysis of fluid motion – Continuity and Navier Stokes equation, Euler and Bernoulli's Equation and their applications, introduction to computational fluid dynamics - necessity, limitations and applications. (6 + 3)

FLOW THROUGH PIPES AND FLOW MEASUREMENT DEVICES : Boundary layer theory, Hagen - Poiseuille and Darcy's equations for friction and pressure drop, Helmholtz's Theorems, Flow through pipes - Major and minor losses through pipes, Measurement of discharge - Venturi and Orifice Meter, Flow Nozzle, Pitot Tubes, Multi - Hole Probe and anemometer. (6 + 3)

FLUID MACHINERY : Theory of turbo machines - Hydraulic efficiency - Velocity components at the entry and exit of the rotor

- Velocity triangle for single stage radial flow and axial flow machines, Analysis and problem solving - Centrifugal pumps, turbines, Reciprocating pumps and Rotary pumps - Working and performance analysis. (6 + 3)

Total L: 30 +T: 15 = 45

TEXT BOOKS:

1. Yunus A Cengel, John M Cimballa , "Fluid Mechanics - Fundamentals and Application", 3rd Edition, Tata McGraw Hill Publishing Company, New Delhi - Indian Edition, 2018.
2. Munson BR, Young DF, Okiishi TH, Huebsch WW , "Introduction to Fluid Mechanics", 5th Edition, John Wiley and Sons, USA, 2011.

REFERENCES:

1. Streeter, Wylie, Bedford , "Fluid Mechanics", McGraw- Hill, NewYork, 1998.
2. Irwing H Shames , "Mechanics of Fluids", McGraw Hill Inc.,, New York, 2002.
3. Robert W Fox, Alan T Mc.Donald , "Introduction to Fluid Mechanics", John Wiley and Sons, 2005.
4. Merle C Potter, David C Wiggert , "SCHAUM'S Outline of Fluid Mechanics", Tata McGraw Hill Edition, New Delhi, 2008.

19A403 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

3 0 0 3

ELECTRIC CIRCUITS : Ohm's law, Kirchoff's Laws, solving simple DC Circuits-single phase AC circuit fundamentals-Power, Power factor-solving simple AC circuits- Introduction to three-phase AC circuits. (8)

ELECTRICAL MACHINES : DC MOTORS: Principle of Operation-types-torque equation - speed-torque characteristics-losses and efficiency- speed control of DC motors-Electric Braking AC MACHINES: Single phase Transformers - Construction and working principle, 3 phase Induction Motor-construction-Principle of operation- types-torque equation-speed -torque characteristics-1 phase Induction Motor-Principle of operation-types – Industrial Applications (12)

ELECTRONIC DEVICES : Operation of PN junction diodes, VI characteristics, zener diode, BJT, types-CB, CE, CC configurations, input and output characteristics, JFET - working principle and characteristics - Comparison of BJT and FET. MOSFET-types, principle of operation and characteristics, Opto Electronic Devices - Introduction, types, photo conductive cells, photo diode, phototransistor, Light emitting diode-Principles and Applications. (8)

ELECTRONIC CIRCUITS : (Qualitative analysis only) Half wave and full wave rectifier, capacitive filters, zener voltage regulator, RC- coupled amplifier, frequency response, RC phase shift oscillator. LINEAR INTEGRATED CIRCUITS: Operational amplifiers, Ideal op-amp characteristics, Inverting and Non-inverting amplifier, op-amp applications - Adder- Subtractor, integrator, differentiator, comparator, zero crossing detector. (10)

DIGITAL ELECTRONICS : Number systems-representation of signed numbers: 1's complement and 2's complement, logic gates, Half adder, full adder, Flip flops, RS,JK,JK Master slave, D and T type, counters and shift registers (7)

Total L: 45

TEXT BOOKS:

1. Mehta V K, Rohit Mehta , "Principles of Electrical Engineering and Electronics", S.Chand & Co. Limited, New Delhi, 2014.
2. Muthusubramanian R, Salivahanan S , "Basic Electrical, Electronics and Computer Engineering", Tata McGraw Hill, 2012.

REFERENCES:

1. Bhattacharya S K , "Basic Electrical and Electronics Engineering", Pearson, 2012.
2. Rajput R K , "Basic Electrical and Electronics Engineering", 2nd Edition, University Science Press, 2012.
3. Gupta B R, Singhal Vandana , "Electrical and Electronics Engineering", S Chand, 2010.
4. Theraja B L , "Fundamentals of Electrical and Electronics Engineering", S. Chand, 2006.

19A404 DYNAMICS OF MACHINERY

2 1 0 3

STATIC FORCE ANALYSIS OF MECHANISM : Free Body diagram - conditions of equilibrium - two, three and four force members - Static force analysis of four bar and slider crank mechanism - effect of friction. (6 + 3)

DYNAMIC FORCE ANALYSIS OF MECHANISM : Inertia force - D'Alembert's principle - Dynamically equivalent two- point mass system - Dynamic force analysis of four bar and slider crank mechanism. (6 + 3)

FLYWHEEL : Turning moment diagram - fluctuation of energy and speed - weight of flywheel required - Dimensions of the flywheel rims. (4 + 2)

BALANCING : Balancing of revolving and reciprocating masses in single plane and several planes - primary & secondary forces and couples - Balancing of multi-cylinder inline engine - Balancing of V-Engines - Balancing of Radial Engines by direct and reverse crank technique. (6 + 3)

VIBRATIONS : Definitions, Types of Vibrations, Basic features of vibratory systems, Degrees of Freedom - Free Longitudinal Vibration - Undamped and Damped, Equation of Motion, Natural frequency, Logarithmic decrement - Forced longitudinal

vibrations - Undamped and Damped, Magnification factor, Transmissibility, vibration isolation, forcing due to unbalance and support motion - Quarter car model - Free Torsional vibration - two and three rotor systems, geared systems, Torsionally Equivalent shaft. (8 + 4)

Total L: 30 +T: 15 = 45

TEXT BOOKS:

1. John J. Uicker Jr., Gordon R. Pennock, Joseph E. Shigley , "Theory of Machines and Mechanisms", 5th Edition, Oxford University Press, 2016.
2. S S Rattan , "Theory of Machines", 4th Edition, McGraw Hill Education, 2017.

REFERENCES:

1. Thomas Bevan , "Theory of Machines", 3rd Edition, CBS Publishers & Distributors, 2005.
2. J S Rao, R V Dukkupati , "Mechanism and Machine Theory", 2nd Edition, New Age International Publisher, 1992.
3. C S Sharma, Kamlesh Purohit , "Theory of Mechanisms and Machines", 1st Edition, Prentice hall of India private limited, New Delhi, 2006.
4. Sadhu Singh , "Theory of Machines: Kinematics and Dynamics", 3rd Edition, Pearson Education India, 2011.

19A405 ENGINEERING DESIGN

3 1 0 4

DESIGN FOR STATIC AND FLUCTUATING LOAD : Concepts of design, Preferred numbers - Concurrent engineering - Static stress equation in axial, bending and torsional loading - Criteria for failure - Factor of safety - Static loading - Combination of normal and shear stresses - Principal stresses - Theories of failure. - Fluctuating load - Mechanism of fatigue failure, fatigue limit and fatigue strength, S-N curves, Soderberg, Goodman and Gerber equations. (9 + 3)

DESIGN OF SHAFTS, KEYS AND COUPLINGS : Design of shafts based on strength, rigidity and critical speed - Design of keys and keyways - Design of rigid and flexible couplings - Knuckle joints. (9 + 3)

DESIGN OF BEARINGS AND SPRINGS : Sliding contact and rolling contact bearings - Cubic mean load, variable load, probability of survival - Selection of bearings - Helical springs, stresses and deflection in round wires - Concentric springs - accounting for variable stresses - Design of leaf springs - stress and deflection equations. (9 + 3)

RIVETED, BOLTED AND WELDED JOINTS : Strength equations, efficiency, design of riveted joints. - Thread forms, initial stress, stresses due to external loads, elastic analysis of bolted joints for pressure vessel flanges. - Welded joints, types, weld symbols, strength of welds, centrally loaded unsymmetrical sections, axially loaded and eccentrically loaded joints. (9 + 3)

TRANSMISSION DRIVES : Design of Spur and Helical Gears - Design of Flat belts and pulleys - Selection of V belts and pulleys - Design of Transmission chains – Sprockets. (9 + 3)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. Shigley Mische , "Mechanical Engineering Design", McGraw Hill, New Delhi, 2011.
2. Bandari V B , "Design of Machine Elements", Tata McGraw Hill, 2018.

REFERENCES:

1. Faculty of Mechanical Engineering, PSG College of Technology , "Design Data: Data Book of Engineers", Kalaikkathir Achchagam, Coimbatore, 2018.
2. Gope P. C , "Machine Design: Fundamentals and applications", PHI Learning Pvt Ltd, New Delhi, 2012.
3. Robert L Mott , "Machine Elements in Mechanical Design", Pearson Asia, New Jersey, 2004.
4. Spotts M F, Shoup T E, Hornberger L E , "Design of Machine Elements", 8th Edition, Pearson, Noida, 2016.

19A406 AUTOMOTIVE POWER TRAIN

3 0 0 3

SI ENGINES : Introduction – Otto cycle-Four stroke cycle- Combustion – Knocking –A/F ratio requirements – carburetion – Variable valve timing – MPFI- Electronic engine control. (9)

CI ENGINES : Introduction – Diesel cycle- diesel engine combustion –detonation – fuel requirements-Four stroke cycle- Combustion – Knocking – CRDI – different types of combustion chambers. (9)

CLUTCH AND GEAR BOX : Role - positive and gradually engaged types - types of clutches - single plate clutch - coil spring type and diaphragm spring type - multiple plate clutch - centrifugal clutch - calculation of torque transmission - over running clutch.- Need for a gearbox - types of gear boxes - sliding mesh - constant mesh and synchromesh gear boxes - calculation of gear ratios - epicyclical gearboxes - overdrives - transfer case – auxiliary gearbox - gear shifting mechanisms. (9)

AUTOMATIC TRANSMISSION : Need for fluid coupling and torque converters - Borg Warner type - control mechanisms - limitations. Transmission Electronics - Automated Manual Transmission (AMT). (9)

DRIVE LINE AND AXLE : Chain drive - propeller shaft drive - torque reaction and drive thrust - Hotchkiss drive - Torque tube drive - universal joints - trunnion type - ring type - flexible disc type - constant velocity joint type - swinging arm drives- Need for final drive and differential - types of final drives - single reduction and double reduction final drives - differential and its types - conventional and non-slip differentials - differential lock - Inter axle differential transaxle types. (9)

Total L: 45

TEXT BOOKS:

1. Ganesan V , "Internal Combustion Engines", 4th Edition, TaTa McGrawHill Publishing Company, 2015.
2. Richard Stone , "Introduction to Internal Combustion Engines", 4th Edition, Palgravre McMillan Publishers, 2013.

REFERENCES:

1. David Crolla , "Automotive Engineering: Powertrain, Chassis System and Vehicle Body", 2nd Edition, Elsevier Publishers, 2009.
2. Allan Bonnick , "Automotive Powertrain Science and Technology", Second, Routedge Publishers, 2013.

19A410 THERMAL ENGINEERING AND FLUID MACHINERY LABORATORY

0 0 2 1

THERMAL ENGINEERING LABORATORY :

1. Experimental study on valve timing diagram in 4-stroke engine and 2-stroke cut model
2. Performance test on constant speed 4-stroke diesel engine
3. Variable speed test on multi-cylinder diesel engine
4. Heat balance test on 4-stroke diesel engine
5. IC engine performance evaluation using PC interface

FLUID MACHANICS LABORATORY :

1. Calibration and comparison of instruments for measuring flow through pipes-orifice, venturi meter, water meter and rotameter
2. Model study in wind tunnel
3. Performance test on pumps
4. Load test on reaction turbine
5. Performance test on axial flow fan

Total P: 30

REFERENCES:

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

19A411 BASICS OF ELECTRICAL AND ELECTRONICS LAB

0 0 2 1

LIST OF EXPERIMENTS :

1. Verification of Ohm's and Kirchoff's Laws
2. Measurement of Power and Power Factor in Single Phase RLC Circuit
3. Mechanical Characteristics of DC Shunt and Compound Motor
4. Load Test on 3 Phase Induction Motor
5. Electric Braking of 3 Phase Induction Motor (Dynamic Braking / Plugging)
6. Study of Half Wave and Full Wave Rectifiers with and without Filters
7. RC Coupled Amplifier
8. Application of Operational Amplifier : Adder, Subtractor, Integrator, and Differentiator
9. Study of Logic Gates and Implementation of Binary Adder / Subtractor
10. Implementation of Modulo – 16 Counter

Total P: 30

REFERENCES:

1. Department of EEE , "Manual Prepared by EEE Department", PSG College of Technology, Coimbatore, 2010.

19O412 INDIAN CONSTITUTION

2 0 0 0

INTRODUCTION : Evolution of Indian Constitution; Significance of Constitution; Composition; Preamble and its Philosophy.(4)

RIGHTS, DUTIES AND DIRECTIVE PRINCIPLES : Fundamental Rights- Writs and Duties, Directive Principles of State Policy. (6)

COMPOSITION OF PARLIAMENT AND FEDERALISM : Union Government, President and Vice President, Houses of the Parliament and their functions; Composition of State Legislature; Powers, Functions and Position of Governor, Function of Chief Ministers, Council of Ministers; The Indian Federal System, Administrative Relationship between Union and States. (8)

BILLS AND CONSTITUTION AMENDMENT PROCEDURE : Types of Bills, Stages of passing of Bill into an Act, Veto Power, Constitution Amendment Procedure, Various Amendments made and their significance for India. (6)

JUDICIARY : Supreme Court and High Court; Functions and powers, Judicial Review. (6)

Total L: 30

TEXT BOOKS:

1. Subash C. Kashyap , "Our Constitution", 5th Edition, NBT, India, New Delhi, 2015.
2. Basu D D , "Introduction to the Construction of India", 20th Edition, Prentice Hall of India, New Delhi, 2011.

REFERENCES:

1. Brij Kishore Sharma , "Introduction to the Constitution of India", 8th Edition, Prentice Hall of India, New Delhi, 2017.
2. Hoshiar Singh , "Indian Administration", 1st Edition, Pearson Education, New Delhi, 2011.
3. Jain M C , "The Constitution of India", 5th Edition, State Mutual Book & Periodical Service, Limited, New Delhi, 2006.
4. Shukla V N , "Constitution of India", 13th Edition, Eastern Book Company Limited, New Delhi, 2017.

19Q413 SOFT SKILLS DEVELOPMENT

0 0 2 1

SOFT SKILLS DEVELOPMENT:

1. Body Language and Professionalism
2. Interpersonal skills
3. Goal setting
4. Impression Management
5. Team Building
6. Time Management
7. Stress Management
8. Convincing Skills
9. Motivation
10. Change Management
11. Communication Confidence
12. Group discussion basics
13. Personal Interview basics
14. Resume writing

Total P: 30

REFERENCES:

1. Jeff Butterfield , "Soft Skills for Everyone", 6th Edition, Cengage Learning, Delhi, 2015.
2. Rao M S , "Soft Skills - Enhancing Employability", LK International Publishing House, New Delhi, 2011.

SEMESTER – 5

19A501 HYDRAULICS AND PNEUMATICS

3 0 0 3

ELEMENTS OF HYDRAULIC SYSTEMS : Introduction to fluid power, properties - Hydraulic fluids, air - Selection of hydraulic fluids, comparison between hydraulics and pneumatics - Pumps, motors and cylinders - Types, characteristics. construction details - Valves for control of direction, flow and pressure, types, construction details. (9)

HYDRAULIC SYSTEM DESIGN AND INDUSTRIAL APPLICATION : Power pack-elements, design - Pipes- material, pipe fittings. seals and packing. maintenance of hydraulic systems - Selection criteria for cylinders, valves, pipes - Heat generation in hydraulic system - Circuits for deceleration, regenerative circuits, differential circuits, feedcircuits, sequencing circuits, synchronizing circuits, fail-safe circuits - Design of hydraulic circuits . (9)

ELEMENTS OF PNEUMATIC SYSTEMS : Compressors- types, selection -Symbols of pneumatic elements - Cylinders - types, typical construction details - Valves – Types, typical construction details. (9)

PNEUMATIC SYSTEMS DESIGN AND INDUSTRIAL APPLICATIONS : General approach, travel step diagram – Types sequence control, cascade, step counter method - K.V.Mapping for minimization of logic equation. Metal working, handling, clamping, application with counters - Design of pneumatic circuits. (9)

ADVANCED TOPICS IN HYDRAULICS AND PNEUMATICS : Electro pneumatics, ladder diagram - Servo and Proportional valves - types, operation, application - Hydro-Mechanical servo systems - PLC-construction, types, operation, programming. (9)

Total L: 45

TEXT BOOKS:

1. Yeaple F.D , "Hydraulic and Pneumatic Power and Control:Design", McGraw-Hill, USA, 2007.
2. Srinivasan R , "Hydraulic and Pneumatic Controls", Vijay Nicole Imprints Private Ltd, Chennai, 2011.

REFERENCES:

1. Majumdar S.R , "Oil Hydraulic Systems: Principles and Maintenance", Mcgraw Hill Education (I) P Ltd, Chennai, 2011.
2. Rohner P , "Fluid Power Logic Circuit Design – Analysis, Design Method and Worked Examples", Macmillan Press Ltd., UK, 1979.
3. Sudinlzman and Venkatesh V C , "Precision Engineering", Tata Mcgraw-Hill Inc., New Delhi, 2014.

19A502 AUTOMOTIVE ELECTRICAL AND ELECTRONICS

3 0 0 3

BATTERIES AND IGNITION SYSTEM : Lead acid and alkaline batteries - construction and working - battery rating - battery charging methods - testing and maintenance. Introduction to Ignition system - Construction and working of magneto coil and battery coil ignition systems - spark plug types - spark advance mechanisms - electronic ignition systems - Transistorized ignition system - solid state ignition systems - capacitor discharge ignition system and distributor less ignition system. (9)

STARTING AND CHARGING SYSTEM : Principle - construction and working of starter motor - working of different starter drive units. Basics of charging system- Alternators – Principle - construction and working – Regulators -Introduction to Start / Stop system - integrated starter generator (ISA/ISG). (9)

SENSORS AND ACTUATORS : Classification of sensors - sensor for speed - throttle position - exhaust oxygen level- manifold pressure - crankshaft position - coolant temperature - exhaust temperature - air mass flow for engine application. Solenoids - stepper motors and relay. (9)

ELECTRONIC FUEL INJECTION : Concept of an electronic engine control system - electronic fuel injection - Throttle body fuel injection - multi point fuel injection - gasoline direct injection - common rail direct injection – electronic ignition control - engine mapping - on-board diagnostics – L- Jetronic Fuel Injection Systems. (9)

LIGHTING SYSTEM AND ACCESSORIES : Details of head light and side light - LED lighting system - head light dazzling and preventive methods. Automatic headlight- daytime running lamps- adaptive brake lights- instrument panel lighting. Accessories - Fuses - cables - connectors and selection - multiplexing and de-multiplexing- Automotive Wiring-Insulated and earth return system - Wiring Diagrams - symbols and standards. Horn – wiper system – power window and mirrors - sun roof – defrosters. (9)

Total L: 45

TEXT BOOKS:

1. Barry Hollembeak , "Automotive Electricity and Electronics", Cengage Learning, Clifton Park, USA, 2007.
2. Kholi P L , "Automotive Electrical Equipment", Tata McGraw Hill Co., Ltd, New Delhi, 2009.

REFERENCES:

1. Joseph Bell , "Diesel Engineering: Electricity and Electronics", Cengage Learning, New Delhi, 2007.
2. Robert Bosch , "Automotive Hand Book", SAE, 2000.
3. Robert Bosch GmbH , "Automotive Electrics Automotive Electronics", 2004.
4. Tom Denton , "Automobile Electrical and Electronics systems", Routledge Taylor & Francis Group, LONDON, 2002.

19A503 VEHICLE SYSTEM DESIGN I

2 1 0 3

INTRODUCTION : Selection of engine based on vehicle performance characteristics - Analysis of forces – Design procedure for cylinder, piston, - piston rings and piston pin . (6 + 3)

CONNECTING ROD AND CRANKSHAFT : Design procedure for connecting rod and crank shaft. (6 + 3)

VALVE ACTUATING MECHANISM AND FLYWHEEL : Design of inlet and outlet valves - Design of valve springs rocker arm, tappet, Cam, camshaft. - Design procedure for flywheel. (6 + 3)

CLUTCH AND GEAR BOX : Design of single and multi-plate clutches: - Selection of gear ratios - Design of gear box. (6 + 3)

DRIVE LINE AND AXLE : Design of propeller shaft and final drive - Design of rear axle - selection of tyres. (6 + 3)

Total L: 30 +T: 15 = 45

TEXT BOOKS:

1. Sundararajamoorthy T V, Shanmugam N, "Machine Design", Anuradha Publications, Kumbakonam, 2017.
2. Lichty, "IC Engines", Kogakusha Co., Limited, Tokyo, 2004.

REFERENCES:

1. Thomas D Gillespie, "Fundamentals of Vehicle Dynamics", SAE, US, 1992.
2. Giles J G, "Engine Design", Illiffee Books Ltd, London, 1968.
3. John Fenton, "Gasoline Engine analysis for CAD", MEP, London, 1986.
4. Faculty of Mechanical Engineering, "Design Data: Data Book of Engineers", Kalaikkathir Achchagam, Coimbatore., 2018.

19A504 DESIGN FOR MANUFACTURE AND ASSEMBLY**2 1 0 3**

DFMA OVERVIEW AND TOLERANCE ANALYSIS : DFMA overview, DFA index, Process capability metrics — Cp, Cpk - Tolerance — feature and geometric, surface finish, review of relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerances - sure fit law, normal law and truncated normal law. (6 + 3)

SELECTIVE ASSEMBLY : Selective assembly, Model - I: group tolerances of mating parts equal; Model - II: total and group tolerances of shaft equal; number of shaft/hole in each group, control of axial play - introducing secondary machining operations, laminated shims. (6 + 3)

DATUM SYSTEMS : Selective assembly, Model I: group tolerances of mating parts equal - Model II: total and group tolerances of shaft equal; number of shaft/hole in each group, control of axial play, introducing secondary machining operations, laminated shims. - Grouped datum systems, grouped datum system with spigot and recess with pin and hole, computation of translational and rotational accuracy, geometric analysis - Datum features - Functional and Manufacturing - Component design -- machining considerations, Redesign for manufacture. (6 + 3)

TRUE POSITION TOLERANCING THEORY : Comparison of Coordinate and true position tolerancing - Floating and Fixed fastener assemblies - Projected tolerance zone, zero true position tolerance, functional gauges – Paper layout gauging - Compound assembly. (6 + 3)

FORM DESIGN OF CASTINGS, WELDMENTS AND TOLERANCE CHARTING TECHNIQUE : Redesign of castings based on parting line considerations, core requirements - Tolerance charting technique, Operation sequence for typical shaft type of components, tolerance worksheets - Centrality analysis. (6 + 3)

Total L: 30 +T: 15 = 45**TEXT BOOKS:**

1. Spotts M F, "Dimensioning and Tolerance for Quantity Production", Prentice Hall Inc, New Jersey, 1983.
2. ASME, "Dimensioning and Tolerancing - Engineering Drawing and Related Documentation Practices", ASME, New York, 2009.

REFERENCES:

1. Oliver R Wade, "Tolerance Control in Design and Manufacturing", Industrial Press Inc, New York, 2008.
2. James G Bralla, "Hand Book of Product Design for Manufacturing", McGraw Hill Publications, 1986.
3. Harry Peck, "Designing for Manufacture", 1st Edition, Pitman Publications, London, 1983.
4. Paul J Drake Jr, "Dimensioning and Tolerancing Handbook", McGraw-Hill, New York, 1999.

19A505 ALTERNATE POWER TRAIN**3 0 0 3**

INTRODUCTION : - Fundamentals of Vehicle Propulsion and Braking - General description of vehicle movement - vehicle resistances - dynamic equations - powertrain tractive effort and vehicle speed –vehicle performance - operating fuel economy - braking performance. (9)

HYBRID ELECTRIC VEHICLES : Concept of hybrid electric drive train - architecture of hybrid electric drivetrains - electrical coupling –mechanical coupling - torque –speed coupling - regenerative braking - electric vehicle architectures - types - range extenders - well-to-wheel performance analysis. (9)

ELECTRIC PROPULSION SYSTEMS : Four - quadrant operation - rated and base speed - peak operation characteristics - brushed DC machines - induction machines - variable speed operation - machine characterization - permanent magnet AC machines - surface — interior - constant current and power transformation traction drives and three-phase inverters. (9)

ENERGY STORAGE SYSTEMS : Cell types - chemistries - operating and performance parameters - energy management systems - optimization and sizing — modeling and simulation - quasistatic modeling of Batteries - dynamic modeling of batteries - supercapacitors. (9)

FUEL CELL AND SOLAR VEHICLES : Electrochemistry - thermodynamics - energy equations - fuel - cell systems - equivalent circuit of a fuel cell - fuel - cell electric and fuel cell hybrid vehicles - hydrogen storage systems - PEMFC- DMFC - solar - hybrid

solar vehicles -MPPT algorithms.

(9)

Total L: 45

TEXT BOOKS:

1. Guzzela.L and Sciarretta , "Vehicle Propulsion systems-Introduction to Modeling and Optimization", Springer, Verlag-Berlin, 2014.
2. Eshani.M, Gao. Y, Lngo. S and Ebrahimi , "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", Newark, CRC Publishers, Newark, 2018.

REFERENCES:

1. Hayes.G and Goodarzi , "Electric Powertrain- Energy systems, power electronics and drives", Jhon Wiley, Sussex, 2018.
2. Mi Chris and Masur Abul , "Hybrid electric vehicles-Principles and Applications with Practical Perspectives", John Wiley, New Jersey, 2018.

19A510 AUTOMOTIVE ELECTRICAL AND ELECTRONICS LABORATORY

0 0 2 1

1. Study of 8 bit microcontroller architecture & ARM processor.
2. Study of an integrated development environment.
3. 8 bit arithmetic and logic operations.
4. Code conversion and Waveform (square and rectangle) generation
5. Display interface using microcontroller
6. Keyboard interface using microcontroller.
7. Sensor interface using microcontroller.
8. Stepper motor interface using microcontroller.
9. DC motor interface using microcontroller.
10. Simulation of automotive lighting system.

Total P: 30

REFERENCES:

1. Faculty of Automobile Engineering , "Laboratory Manual, Department of Automobile Engineering", 2015.

19A511 VEHICLE PERFORMANCE CHARACTERISTICS LAB

0 0 2 1

1. Determination of centre of gravity (X-axis)
2. Determination of centre of gravity (Y-axis).
3. Determination of centre of gravity (Z-axis).
4. Determination of steady state characteristics of vehicle
5. Determination of draw-bar pull.
6. Determination of maximum draw-bar pull at different surfaces and coefficient of adhesion.
7. Determination of stopping distance
8. Estimation of natural frequency for automotive components
9. Determination of Steering gear ratio
10. Estimation of rolling resistance.

Total P: 30

REFERENCES:

1. Department of Automobile Engineering , "Laboratory Manual", 2012.

19A512 ENGINE TESTING AND TROUBLE SHOOTING LAB

0 0 2 1

1. Dismantling and assembling engines and measurement of engine parts
2. Radiator pressure test and thermostat valve test
3. Compression test, vacuum test and valve clearance adjustment on petrol / diesel engine.
4. Injector testing and servicing
5. Ignition system trouble shooting and servicing and testing and trouble shooting of alternator, starter motor and battery
6. Performance test on SI and CI engines
7. Performance test on VCR engine
8. Diagnostic of engine using engine tester
9. Exhaust gas emission measurement on diesel and petrol engine
10. Morse test

Total P: 30

REFERENCES:

1. Karthikeyan M, Magesh Kannan V , "Laboratory Manual prepared by Department of Automobile Engineering", 2019.
2. Ken Pickerill , "Automotive Engineering (Engine Performance- Shop Manual)", Cengage Learning Yes Dee Publishing Pvt. Ltd, 2010.
3. Chistopher Hadfield , "Automotive Engineering (Engine Repair & Rebuilding - Classroom Manual)", Cengage Learning Yes Dee Publishing Pvt. Ltd, 2010.
4. Tim Gilles , "Maintenance of Automotive Engines", Cengage Learning Yes Dee Publishing Pvt. Ltd, 2009.

19Q513 BUSINESS AND MANAGERIAL COMMUNICATIONS

0 0 2 1

BUSINESS AND MANAGERIAL COMMUNICATIONS :

1. Advanced Group discussion
2. Advanced Resume writing
3. Mock Group discussion
4. Advanced Personal Interview
5. Mock Personal Interview
6. Cracking special Interviews
7. Essential Grammar for Placements
8. Vocabulary for Placements
9. Email writing
10. Paragraph writing
11. Essay writing

Total P: 30

REFERENCES:

1. Priyadarshi Patnaik , "Group Discussion and Interview Skills", Cambridge, New Delhi, 2011.
2. Hari Mohan Prasad, Rajnish Mohan , "How to Prepare for Group Discussion and Interview", 2nd Edition, Tata McGrawhill, New Delhi, 2009.

SEMESTER - 6

19A601 VEHICLE DYNAMICS

3 1 0 4

INTRODUCTION : Earth and vehicle coordinate system. Longitudinal - lateral and vertical vehicle dynamics. Dynamic axle loads. Road loads - Aerodynamic forces and moments - viscosity effects - separation and its control; aerodynamic lift and its control - ground effect - styling for minimum drag. Rolling resistance. (9 + 3)

PERFORMANCE MODE : Acceleration - Free body diagram of accelerating vehicle - maximum transferable tractive force - gradability - Deceleration - free body diagram of decelerating vehicle - maximum decelerating rates -stopping distance - maximum braking force. Vehicle performance. (9 + 3)

RIDE MODE : Degrees of freedom-single - two and multi degrees of freedom system - free - forced and damped vibration - model of an automobile - magnification factor - transmissibility - vibration absorbers - pitch and bounce motion - oscillation centers - active and semi active suspension - orthogonality of mode shapes - modal analysis. Quarter car modeling and simulation using a suitable tool. (9 + 3)

VEHICLE STABILITY SYSTEM : Requirements - stability of vehicle on slope - on curved and banked road. - choice of suspension spring rate - calculation of effective spring rate. Tires - mechanics - Electronic stability control - Differential Braking systems - Controlled Architecture - Desired Architecture - Desired side slip angle - Pacejaka's Tire Model using a suitable tool. (9 + 3)

HANDLING MODE : Vehicle control-low speed cornering and static steering-Ackerman steering geometry - steady- state cornering -steering factors - vehicle control parameters (under steer - neutral steer and over steer) - roll steer - compliance steer - ride steer - slip angle steer - steady state handling-lateral acceleration gain - characteristic speed - yaw velocity gain - critical speed - effect of braking on vehicle handling. - Assignment based on a simulation tool. (9 + 3)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. Thomas D Gillespie , "Fundamentals of Vehicle Dynamics", 4th Edition, SAE USA, 2014.
2. Rao S.S , "Mechanical Vibrations", 3rd Edition, Pearson Education Publication, 2014.

REFERENCES:

1. GiriN.K , "Automobile Mechanics", 4th Edition, Khanna Publishers, 2013.
2. Cole D.E. , "Elementary Vehicle Dynamics", 4th Edition, Ann Arbor, 2011.

19A602 PRODUCTION PLANNING AND OPERATIONS RESEARCH

2 1 0 3

PRODUCTION PLANNING AND CONTROL : Objectives and benefits of planning and control - Functions of production control - Types of production - job, batch and continuous - Product development and design - Marketing aspect - Functional aspects - Operational aspect - Durability and dependability aspect - aesthetic aspect, Profit consideration - Standardization, Simplification & specialization - Break even analysis - Economics of a new design. (6 + 3)

WORK-STUDY : Method study, basic procedure - Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study - work measurement - Techniques of work measurement- Time study - Method study - Synthesis from standard data. (6 + 3)

PRODUCT PLANNING AND PROCESS PLANNING : Product planning - Extending the original product information - Value analysis - Problems in lack of product planning - Process planning and routing - Pre requisite information needed for process planning - Steps in process planning. (6 + 3)

SEQUENCING AND NETWORKS SEQUENCING : Problem with N jobs and 2 machines - 3 machines and 'M' machines. Network models - Construction of Networks - Project Network - CPM and PERT - Critical Path – Scheduling. (6 + 3)

INVENTORY MODELS: Various Costs and Concepts - EOQ - Deterministic inventory models Production models - Basic concepts - Advantages and Disadvantages. (6 + 3)

Total L: 30 +T: 15 = 45

TEXT BOOKS:

1. Frederick S. Hillter, Gerald J. Lieberman, Bodhibrata Nag, Preetam Basu , "Introduction to Operation Research", 9th Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2012.
2. James.B.Dilworth , "Operations management - Design, Planning and Control for manufacturing and services", International, McGraw Hill, 1992.

REFERENCES:

1. Samson Eilon , "Elements of production planning and control", Universal Book Corpn, 1984.
2. Elwood S.Buffa, Rakesh K.Sarin , "Modern Production / Operations Management", Eighth, John Wiley and Sons, 2000.
3. Kanishka Bedi , "Production and Operations management", Oxford university press, 2007.
4. Stephen N. Chapman , "The Fundamentals of Production Planning and Control", 2nd Edition, Pearson Education, New Delhi, 2009.

19A603 VEHICLE SYSTEM DESIGN-II

2 1 0 3

FRAME AND SUSPENSION : Force analysis and Design procedure for frame. - Design of Suspension system – leaf spring, - coil spring and torsion spring. (6 + 3)

FRONT AXLE AND STEERING : Force analysis. Design procedure for front axle. - Determination of steering torque, -design of linkages, steering gear box. (6 + 3)

BRAKING SYSTEM : Force analysis, design of drum and disc brakes - design of actuating mechanisms –mechanical, - hydraulic and pneumatic. (6 + 3)

ERGONOMICS AND SAFETY : car interior ergonomics, ergonomics system design - seating dimensions dash board instruments - commercial vehicle cabin ergonomics and goods vehicle layout - Crash tests, forces in roll over, head on impact. (6 + 3)

VEHICLE BODY ANALYSIS : criteria for vehicle body design, sheet metal representation - Unit load method for structural deflection - Car body idealization, and bus body idealization for analysis, - adhesives. (6 + 3)

Total L: 30 +T: 15 = 45

TEXT BOOKS:

1. Heinz Heisler , "Advanced Vehicle Technology", SAE International, 2002.
2. John Fenton , "Handbook of Automotive Body and Systems Design", John Wiley & Sons,, 2013.

REFERENCES:

1. Heldt.P.M , "Automotive Chassis", Chilton Co, New York, 1992.
2. Steeds. W , "Mechanics of Road Vehicles", Illiffe Books Ltd., London, 2010
3. Giles.K.G , "Steering, Suspension and tyres", Illiffe Books Ltd, London, 2008.
4. Jnusz Pawlowski , "Vehicle Body Engineering", Business books limited, 2003.

19A604 FINITE ELEMENT ANALYSIS

3 1 0 4

INTRODUCTION TO FEM : Engineering design analysis -meaning and purpose, Steady state, propagation and transient problems. - Basic concepts of FEM - Advantages and limitations of FEM, Test for convergence, Element choice. - Commercial finite element packages organization - advantages and limitations, Matrix approach – Handling of simultaneous equations - Gaussian elimination method and Choleski method. - Solving eigen value problems Jacobi method, Numerical integration. (8 +2)

ONE DIMENSIONAL ANALYSIS : Coordinates and shape functions - Assembly of stiffness matrix - load vector – Finite element equations - 1D spar and spring elements. Dynamic analysis. - Consistent and lumped mass matrices. Formulation of element mass matrices. Equations of motion for dynamic problems. Free vibration problem formulation . (10+4)

TWO DIMENSIONAL ANALYSIS : Coordinates and shape functions – Stiffness matrix- beam elements, 2D triangular and quadrilateral elements, - Isoperimetric elements. Treatment of boundary condition. (9+3)

HEAT TRANSFER AND FLUID FLOW ANALYSIS : Basic equations of heat transfer and fluid flow problems. - Finite element formulation. One dimensional heat transfer and fluid flow problems. (9+3)

DESIGN OF AUTOMOTIVE STRUCTURES : Force distribution on different parts of automotive structure, - design of the parts, static, dynamic and thermal analysis of the parts using finite element method. - Material redistribution to minimize stresses and deflection. - Optimization of location of ribs to maximize rigidity. (9+3)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. Logan DL , "A First Course in the Finite Element Method", Ceneage Learning India Pvt Ltd, 2011.
2. Tirupathi R. Chandrupatla, Ashok D. Belegundu , "Introduction to Finite Elements in Engineering", Prentice Hall India, 2011.

REFERENCES:

1. Logan DL , "Computational Fluid Dynamics – The Basics with Applications", International Edition, 2012.
2. Rao SS , "The Finite Element Method in Engineering", Elsevier, 2017.
3. Reddy J.N , "An Introduction to Finite Element Method", McGraw Hill International, 2017.
4. Seshu P , "A Text book on Finite Element Analysis", Prentice Hall of India, 2013.

19A605 AUTOMOTIVE CONTROL SYSTEM

3 0 0 3

INTRODUCTION : Linear systems - dynamic model - dynamic response - mechanical systems - basic properties of feedback systems transfer function - basic equation for control - control of dynamics of error - system type. (9)

TIME RESPONSE ANALYSIS : First order - second order - test signals - design specifications - transient and steady state performance - disturbance rejection - poles, zeros and systems stability - root locus analysis and design - Routh Hurwitz criterion. (9)

FREQUENCY RESPONSE SYSTEMS : Frequency domain - sinusoidal signals - magnitude and phases - logarithmic frequency scales - presentation of phase and gain margins - Bode plot - nyquist plot - phase margin -performance specification stability - Nyquist stability criteria. (9)

STATE SPACE AND PID CONTROL : PID Tuning procedures - process reaction curve - PID parameter calculation -state variable structure - pole placement – controllability - observability - investigation of state feedback. (9)

NON-LINEAR SYSTEMS : Systems: Linearization - non - linear examples - non - linear state variable model – linear approximation through Taylor series - state estimation - introduction –Kalman Filter – examples. (9)

Total L: 45

TEXT BOOKS:

1. Franklin.G, Powell D and Emami A , "Feedback control of Dynamic Systems", Fifth, Pearson Education, New Delhi, 2014.
2. Wilkie J, Johnson M, and Katebi R , "Control Engineering An Introductory Course", Fourth, Plagrove, 2012.

REFERENCES:

1. Gopal M , "Control Systems – Principles and Design", Fourth, Tata McGraw-Hill, New Delhi, 2016.
2. Norman S Nise , "Control System Engineering", Sixth, John Wiley & Sons, Noida, 2011.
3. Ogata K , "Modern Control Engineering", Sixth, Prentice Hall, Delhi, 2015.

19A611 DESIGN AND ANALYSIS LABORATORY

0 0 2 1

1. Static Structural Analysis : Automotive Structure, Auto Body, Automotive chassis etc.
2. Transient Analysis : Transmission Gears, Shafts , Connecting Rod etc.
3. Crash Analysis : Chassis, Bumper, Bonnet etc.
4. Steady State And Transient Thermal Analysis : Piston, Engine Cylinder, Cylinder Head etc.

5. Modal Analysis : Automotive Structure, Connecting rod, Auto Body etc.
6. Contact Stress Analysis : Gear Pair, Leaf spring, Tyre etc.
7. Stress And Strain Distribution : Composite structure, Entire Vehicle loaded/Unloaded condition
8. Vibration Analysis : Sway bar, Coil Spring etc.
9. Aerodynamic Analysis : Passengers Car, Race Car, Truck etc.
10. Thermal With Mechanical Stress : Brake Disc, Piston rings, Cylinder liner etc.

Total P: 30

REFERENCE:

1. Automobile Engg , "Laboratory Manual", PSG- Automobile Engineering Department, 2019.

19A612 INNOVATION PRACTICES

0 0 2 1

1. Preparing a project brief proposal including
 - a. Problem identification.
 - b. A statement of system / process specification proposed to be developed (Block diagram / concept tree).
 - c. List of possible solutions including alternative and constraints. Cost benefits analysis.
 - d. Time Line of activities.
2. A report highlighting the design finalization (based on functional requirements & standards)
3. A presentation including the following:
 - a. Implementation (Hardware / Software / both). Testing & Validation of the developed system. Learning in the Project.
4. Consolidated report preparation.

Total P: 30

REFERENCE:

1. Department of Automobile Engineering , "Laboratory Manual", 2012.

19Q613 QUANTITATIVE AND REASONING SKILLS

0 0 2 1

1. Number System, Time and Work
2. Percentages , Simple and Compound Interests
3. Time, Speed and Distance
4. Permutation, Combination and Probability
5. Ratio and Proportion
6. Profit, Loss and Partnership
7. Logarithms, Progressions, Geometry and Quadratic Equations
8. Coding and Decoding
9. Series, Analogy and Odd Man Out Visual Reasoning
10. Data Arrangements
11. Blood Relations
12. Clocks, Calendars and Direction Sense
13. Cubes, Logical Connectives and Syllogisms
14. Venn Diagrams, Interpretations and solving

Total P: 30

REFERENCES:

1. Aggarwal R S , "Quantitative Aptitude for Competitive Examinations", 3rd Edition, S Chand Publishing, New Delhi, 2017.
2. ETHNUS , "Aptimithra", 1st Edition, McGraw-Hill Education Pvt Ltd, 2013.
3. FACE , "Aptipedia Aptitude Encyclopedia", 1st Edition, Wiley Publications, Delhi, 2016.

SEMESTER - 7

19A701 METROLOGY AND QUALITY ENGINEERING

3 0 0 3

INTRODUCTION TO METROLOGY : Introduction to Metrology - Fundamental principles and definitions - measurement standards / primary and tertiary standards - distinction between precision and accuracy. - Tolerance grades - Types of fits IS919 - GO and NO-GO gauges- Taylor's principle - design of GO and NO-GO gauges – filler gauges - plug gauges and snap gauges. (9)

COMPARATORS, INTERFEROMETERS AND SURFACE ROUGHNESS MEASUREMENTS : Constructional features and operation of mechanical, optical, electrical/electronic and pneumatic comparators - advantages, limitations and field of applications. - Principles of interference, concept of flatness - flatness testing - optical interferometer and laser interferometer. importance of surface conditions - roughness and waviness - surface roughness standards specifying surface

roughness parameters- Ra, Ry, Rz, RMS value etc. - surface roughness measuring instruments – Tomlinson and Taylor Hobson versions - surface roughness symbols (9)

SCREW THREAD MEASUREMENT, GEAR MEASUREMENTS AND SPECIAL MEASURING INSTRUMENTS : Two wire and three wire methods - floating carriage micro meter. - Gear tooth comparator - Master gears measurement using rollers and Parkinson's Tester - Principles of measurement using Tool Maker's microscope - profile projector - 3D coordinate measuring machine. (9)

QUALITY CONTROL, SQC AND SQC TOOLS : Introduction, definition and concept of quality & quality control - set up policy and objectives of quality control - quality of design and quality of conformance - compromise between quality & cost - quality cost and planning for quality - Importance statistical methods in QC - measurement of statistical control variables and attributes - GANT charts - control charts - X chart, X bar charts - control charts - R charts, P charts and np charts their preparation, analysis and applications. - Elementary treatment on modern SQC tools. (9)

SAMPLING TECHNIQUES : Sampling inspection and basic concepts - OC curves - consumer & producer risk -single & double sampling plans and use of sampling tables. (9)

Total L: 45

TEXT BOOKS:

1. Gupta I.C , "Text Book of Engineering Metrology", Dhanapatrai Publishers, New Delhi, 2003.
2. Gerald M.S , "Statistical Process Control and Quality Improvement", Pearson Education, USA, 2004.

REFERENCES:

1. Jain R.K , "Engineering Metrology", Khanna Publishers, New Delhi, 2009.
2. Douglas Montgomery , "Introduction to Statistical Quality Control", John Wiley and Sons Inc., USA, 2005.
3. Stephen B.V , Marcur J.J , "Statistical Quality Assurance Methods for Engineers", John Wiley and Sons Inc., USA, 2000.

19A703 AUTOMOTIVE EMISSION & NVH CONTROL

3 0 0 3

EMISSIONS FROM SI AND CI ENGINES : Emission formation in SI and CI engines - Factors influencing emission - Effect of pollution on environment and human health - Emission norms : Euro & Bharat norms - Effect of fuel properties and additives - Emissions from alternate fuels. (9)

EMISSION TESTING : Emission test cycles - Constant volume sampling method - Non-dispersive infrared (NDIR) analyzer - Flame ionization detectors (FID) - Chemiluminescence analyzer - Smoke meters - Gas chromatograph. (9)

EMISSION CONTROL TECHNIQUES : Air fuel ratio (A/F) control - Crank case emission control - Fuel evaporation & control - EGR - SCR - Catalytic converters - Particulate traps - Effect of engine combustion modification and control technologies . (9)

NOISE AND NOISE CONTROL : Introduction to sound - Noise measurements - Control of air borne and structure borne noise - Use of absorber and criteria for the selection of materials - Engine noise and control - Brake noise and control - Tyre noise and control - Gear noise and control - Clutch noise and control - Resonators – Reactive and absorptive silencers. (9)

VIBRATION MEASUREMENT AND CONTROL : Introduction and elements of vibration - Source of vibration - Types of vibration - Measurement of vibration: FFT analyzer - Quarter car model analysis - Methods of vibration control:passive, active, semi active control - Vibration isolation - Engine and drive train vibrations. (9)

Total L: 45

TEXT BOOKS:

1. Pundir B P , "Engine Emissions: Fundamentals and Advances in Control", Alpha Science International Ltd, 2017.
2. Matthew Harrison, Butterworth-Heinemann, Burlington , "Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles", 2011.

REFERENCES:

1. James D. Halderman , "Automotive Fuel and Emissions Control Systems", 4th Edition, Prentice Hall, Pearson Education, 2016.
2. Gang Sheng , "Vehicle Noise, vibration and Sound quality", SAE International, 2012.
3. Rajesh Rajamani , "Vehicle Dynamics and Control", 2nd Edition, Springer, 2012.
4. Singiresu.S. Rao , "Mechanical Vibrations", 5th Edition, Prentice Hall, 2010.

19A710 VEHICLE SERVICING LABORATORY

0 0 2 1

VEHICLE SERVICING LABORATORY :

1. Inspection and servicing of different types of clutches.
2. Inspection and servicing of different types of gear boxes
3. Measurement of backlash and run out of differential unit
4. Servicing of transaxle assembly

5. Servicing of different types of rear axle assembly
6. Servicing of steering gear boxes and verification of Ackerman steering geometry
7. Head light beam alignment, tuning of electric horn system and wind screen wiper system
8. Brake system troubleshooting and servicing
9. Electrical system diagnostics
10. Wheel balancing and wheel alignment

Total P: 30

REFERENCES:

1. Anderson Ashburn , " Automotive Trouble shooting and Maintenance ", McGraw-Hill Book Company , 1990." , 1990.
2. Tom Denton , "Advanced Automotive Fault Diagnosis", Elsevier Butterworth-Heinemann, 2011.

19A711 PROJECT WORK I

0 0 4 2

1. Identification of a real life problem in thrust areas.
2. Developing a mathematical model for solving the above problem.
3. Finalization of system requirements and specification.
4. Proposing different solutions for the problems based on literature survey
5. Future trends in providing alternate solutions.
6. Consolidated report preparation of the above.

SEMESTER - 8

19A810 PROJECT WORK II

0 0 8 4

The project work involves the following:

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

Total P:120

PROFESSIONAL ELECTIVES

19A001 AERODYNAMICS OF ROAD VEHICLES

3 0 0 3

INTRODUCTION : Fundamentals of fluid mechanics - flow phenomenon related to vehicles - external and internal flows. (6)

AERODYNAMIC DRAG OF CARS : Cars as a bluff body - flow field around car - air flow to passenger compartment - drag force - types of drag force - analysis of aerodynamic drag - drag coefficient of cars - strategies for aerodynamic development - low drag profiles. (10)

SHAPE OPTIMIZATION OF CARS : Front end shape modifications - front and rear wind shield angle - A and C pillar - front and rear spoilers - Roof modifications - rear end shape modifications - boat tailing - hatch back - fast back and square back - dust flow patterns at the rear - effects of gap configuration - effect of fasteners. (10)

VEHICLE HANDLING : Origin of forces and moments on a vehicle - lateral stability - methods to calculate forces and moments - vehicle dynamics under side force and winds - steady and cornering effect - steering angle and slip angle - under steer and over steer gradient - suspension effects on cornering - roll moments on front and rear axles - dirt accumulation on the vehicle - wind noise - drag reduction in commercial vehicles. (10)

WIND TUNNELS FOR AUTOMOTIVE AERODYNAMICS : Introduction - principle of wind tunnel technology - limitation of simulation - stress with scale models - full scale wind tunnels - measurement techniques - equipment and transducers - road testing methods - numerical methods. (9)

Total L: 45

TEXT BOOKS:

1. Thomas Christian Scheutz , "Aerodynamics of Road vehicles", 5th Edition SAE International 2012
2. William Siebert , 'Aerodynamics of Road vehicles", 3rd Edition, Prentice Hall 2007

REFERENCES:

1. McCallen R, Browand F, Ross J , "The Aerodynamics of Heavy Vehicles: Trucks, Buses, and Trains", Springer, 2004.
2. SAE , "Vehicle Aerodynamic", SP-1145, SAE, 1996.

19A002 AUTOMATIC TRANSMISSION

3 0 0 3

MECHANICAL : Principle of centrifugal clutches - comparison between conventional and centrifugal clutches - centrifugal clutches used in two wheeler - over drives – Principle - operation - types - advantages and limitations (9)

HYDRODYNAMIC DRIVES : Principle of fluid coupling - construction, operation and characteristics - fluid coupling with conventional gear boxes - Introduction to torque converters, comparison between fluid coupling and torque converters - performance characteristics - slip - principles of torque multiplication - types of torque converters (9)

HYDRO-MECHANICAL DRIVES : Major components, principle of planetary gear trains - actuating mechanism - controls system – Types - Manual, governor, - throttle and hydraulic control systems - Principle of automatic gear shifting - Typical automatic transmissions - Advantages and limitations (9)

HYDROSTATIC DRIVES : Principles of hydrostatic drives - different systems of hydrostatic drives - fixed displacement pump and fixed displacement motor - variable displacement pump and fixed displacement motor - fixed displacement pump and variable displacement motor - variable displacement pump and variable displacement motor applications - plunger type pump and plunger type motor - advantages and limitations – typical hydrostatic drives (9)

ELECTRIC DRIVES : Early Ward Leonard control system - Main features - generator - merits - reverse motion - modified Ward Leonard control system - Main features - modifications. Modern electric drives - Main features - performance characteristics - advantages and limitations. (9)

Total L: 45

TEXT BOOKS:

1. Jack Erjavec , "Automatic Transmissions", Delmar Publishers, 2009.
2. Heinz Heisler , "Advanced Vehicle Technology", SAE, 2012.

REFERENCES:

1. Theraja B.L , "Fundamentals of Electrical Engineering and Electronics", S Chand & Company Ltd, 2009.
2. Tucker H.F , "Automatic Transmission", Van Nostrand Reinhold Company, 1999.
3. Mathias F.B , "Automatic Transmission", Prentice Hall, 1998.
4. John J.P, Tyler G.H , "Industrial Hydraulics", MGH Published, 2010.

19A003 AUTOMOTIVE ELECTRONICS

3 0 0 3

ELECTRONICS IN AUTOMOBILE : Introduction- Body and convenience electronics: vehicle power supply controllers and lighting modules - door control modules - Safety electronics: active safety systems: ABS - ASR - ESP passive safety systems: Restraint systems and their associated sensors in an automobile. Infotainment electronics: Dashboard/instrument cluster - car audio - telematic systems - navigation systems - multimedia systems. (10)

ELECTRONIC ENGINE CONTROLS : Concept of an electronic engine control system - electronic fuel injection - Throttle body fuel injection - multi point fuel injection - gasoline direct injection - common rail direct injection - electronic ignition control - engine mapping - on-board diagnostics - L- Jetronic Fuel Injection Systems. (9)

SENSORS AND ACTUATORS : Classification of sensors - sensor for speed - throttle position - exhaust oxygen level - manifold pressure - crankshaft position - Accelerometer - NOx sensor - coolant temperature - exhaust temperature - air mass flow for engine application. Solenoids - stepper motors and relay. (9)

INTRODUCTION TO RTOS : Comparison of conventional OS with RTOS. Tasks & task states (Pre-emptive & Non- preemptive - scheduler - interrupt - Interrupt latency and context switch latency) - Task - multi-tasking - task synchronization - inter-task communication - shared data problem and its prevention - Features of a typical embedded RTOS ($\mu\text{C}/\text{OS-II}$). (10)

COMMUNICATION PROTOCOLS : Introduction to control networking - Communication protocols in embedded systems - SPI - I2C - USB. Vehicle communication protocols - Introduction to CAN - LIN - FLEXRAY - MOST – AUTOSAR. (7)

Total L: 45

TEXT BOOKS:

1. Denton T , " Automobile Electrical and Electronic Systems", Routledge, 2013.
2. Bosch , "Automotive Electric and Automotive Electronics", 5th Edition, Springer Fachmedien Wiesbaden, 2014.

REFERENCES:

1. William B.Riddens , "Understanding Automotive Electronics: An Engineering Perspective", 8th Edition, Elsevier, 2017.
2. Nicholas Navit , "Automotive Embedded System Handbook", CRC Press Publications, 2013.

19A004 AUTOMOTIVE PRODUCT DEVELOPMENT STRATEGIES

3 0 0 3

INTRODUCTION TO PRODUCT DESIGN : Introduction - principles of new product development - success and failure in new products - risk management - funnel and its stages - quality control of product development and meeting targets - the principles of product styling-virtual perception of product style - attractiveness and product styling process. (9)

PRODUCT PLANNING : Product planning process - aim and opportunities in product planning - competing product analysis - style planning - factors of contextual styling and Intrinsic styling - styling specifications. (9)

GLOBAL PRODUCTS AND ITS PROBLEMS : Importance - challenges and opportunities of global products - changes and complexity in global products - global product problems - multiple causes and its effects - root cause and network of causes and measures - everyday product problems and action. (9)

PLM ENABLING GLOBAL PRODUCTS : Product lifecycle management (PLM) - key characteristics and functions - benefits of PLM - metrics and targets of PLM - PLM applications and data/document management - part/product management - process/workflow management - program/project management. (9)

CHANGES FOR GLOBAL PRODUCTS : Changing roles of product organizations - increased regulation of product - better managed product - multiple of new products - breakthrough computer aided product development. (9)

Total L: 45

TEXT BOOKS:

1. Karl Ulrich, Steven Eppinger, Maria C. Yang , "Product Design and Development", 7th Edition, McGraw-Hill Education, 2019.
2. John Stark , "Global Products", Springer-Verlag London Ltd, 2011.

REFERENCES:

1. Anil Mital, Anoop Desai, Anand Subramanian, Aashi Mital , "Product Development", Butterworth-Heinemann Publications, 2008.
2. Michael Z. Brooke, William Ronald Mills , "New Product Development", Jaico Publishing House, 2008.

19A005 MECHATRONICS

3 0 0 3

INTRODUCTION TO MECHATRONICS SYSTEM : Definition of Mechatronics - introduction to mechatronics systems – need and applications - role of Mechatronics in automation, manufacturing, products and design - elements of Mechatronics - open loop and closed loop control - introduction to sampled data, digital control and multivariable control systems - mathematical model for mechanical and electrical systems, transfer function (12)

TRANSDUCERS AND SENSORS : Importance of sensors in mechatronics - static and dynamic characteristics of sensors - Classification – transducers for measurement of displacement - strain - position - velocity - flow - pressure - temperature - humidity - vibration - liquid level and light sensors (8)

CONTROL ELEMENTS AND ACTUATORS : Control elements - ON/OFF push buttons - control relays - contactors - selector switches - micro switches and solid state switches. Actuators - solenoids - AC and DC motors - servo - stepper and linear motors. Hydraulic and Pneumatic controls - control valves - cylinders and hydro motors. (8)

MICROPROCESSORS AND MICROCONTROLLER AND INTERFACING : Microprocessors - introduction - 8085 architecture - development of simple programs - 8051 Microcontroller architecture - applications- temperature control and stepper motor speed control - Basic concepts of I/O - I/O mapping and memory mapping - 8255 block diagram - port structure. Applications- seven segment display interface - keyboard interface (12)

MEMS : Introduction - MEMS and micro system products - application of micro systems in the automotive industry - working principles of micro systems – micro sensors - micro actuation - MEMS with micro actuators and micro accelerometers (5)

Total L: 45

TEXT BOOKS:

1. Robert H. Bishop, 'Mechatronics an Introduction' , "Mechatronics", Taylor and Francis 2011, .
2. GodfreyC.Onwbolu , "Mechatronics: Principles and Application ",Elsevier 2009, .

REFERENCES:

1. Nitaigour , "Mechatronics principles, concept and application", 2nd Edition Tata-McGraw ,2013.
2. Rajesh Rajamani , "Vehicle Dynamics and Control", Springer-Verlog 2008 , .

19A006 AUTOMOTIVE EMBEDDED SYSTEMS

3 0 0 3

INTRODUCTION TO EMBEDDED SYSTEMS : Embedded Systems Definition - Components of embedded systems - Hardware Module - Microprocessor, microcontrollers, on - chip peripherals - Program memory(PM), Data memory (DM), parallel port structures, timer, input capture & output compare units, ADC, PWM. Embedded system programming - Up - loaders, ISP, ROM emulators, incircuit emulators. Debug Interfaces - BDM and JTAG (10)

HARDWARE MODULES : 16 - bit microcontrollers - architectural overview of C166 family - memory organization, fundamental CPU concepts and optimization measures, on - chip system resources, peripheral event controller (PEC) ad interrupt control, external bus interface, parallel ports, general purpose timers(GPT), watchdog timer, serial channels, capture/compare units, pulse width modulation unit, analog to digital converter, real time clock, on chip I2C bus module, universal serial bus (USB) interface (10)

SOFTWARE DEVELOPMENT TOOLS : Introduction to Integrated development environment (IDE), creating new project, creating new file, adding files to project, options for target, compile and building project, simulation and debugging, set breakpoints, monitor on - chip peripherals using simulators, study of example programs. (9)

INTEGRATION OF HARDWARE AND SOFTWARE : Introduction to microcontroller development kit (easy kit), developing project using IDE software, downloading embedded software into target system, introduction to on - chip debugging resources (JTAG), debugging target system using on - chip debugging support (OCDS). (9)

DRIVE-BY-WIRE : Challenges and opportunities of X - by - wire system and design requirements, steer - by - wire, brake - by - wire, electronic throttle including adaptive cruise control, shift - by - wire. (7)

Total L: 45

TEXT BOOKS:

1. Nicolas Navet and Françoise Simonot-Lion , ""Automotive Embedded Systems Handbook", CRC press, 2009.
2. James K Peckol , ""Embedded Systems – A contemporary Design Too", John Wiley, 2013.

REFERENCES:

1. Arnold Berger , "Embedded System Design: An Introduction to Processes, Tools, and Techniques", CMP Book , , 2001.
2. David E Simon , "An Embedded Software Prime", Pearson Education, Asia, 2009.
3. Wayne Wolf , "Computers as Components", Morgan Kaufmann Publishers, 2009

19A007 VEHICLE CONCEPT STYLING AND DESIGN

3 0 0 3

INTRODUCTION : Drawing in product design - mass production - geometric versus naturalistic drawing - modernist design. basic drawing skills - perspectives - metric projections - spherical projections - orthographic projections - sections and scrap views - tools and materials. (9)

COMPUTER SYSTEMS : The computer processor - system software - display - input devices - hardcopy output - 3D output devices - concept design - evaluating the design - 3D modeling concepts - hybrid approach - commercial computer solutions - drawing in space - creating organic forms. (9)

PRESENTATION DRAWING AND VISUALS : From watercolor washes to markers - painting by numbers - the art of design - visual tricks - making marker drawing - 2D computer programs: paint and vector - 3D computer aided styling (CAS) - creating virtual reality - shading a computer model - ray tracing and radiosity - adding texture - fractals and commercial modelers. (9)

FROM GENERAL ARRANGEMENTS DRAWING TO PRODUCTION : Technical production documentation - the general arrangement drawing - drafting standards - computer aided drafting - geometric constructions - controlling curves - parametric design - CAD data - Exchange standards and all change in the CAD market. (9)

TECHNICAL ILLUSTRATION : Art of technical illustration - techniques of technical illustration - thick and thin lines - sections - cutaways and ghosting - photo-tracing - annotation and labeling - computer aided illustration - interactive technical illustration and commercial solutions. (9)

Total L: 45

TEXT BOOKS:

1. Alan Pipes , "Drawing for Designers", Laurence King Publishing, 2011.
2. Erik Olofsson, Klara Sjölen , "Design Sketching", Keeos Design Books AB, 2005.

REFERENCES:

1. Tony Lewin, Ryan Borroff , "How to Design Cars Like a Pro", Motor Books International, 2010.
2. Stuart Macey, Geoff Wardle, Ralph Gilles, Freeman Thomas, Gordon Murray , "H-Point: The Fundamentals of Car Design & Packaging", Design Studio Press, 2009.
3. Thom Taylor , "How to Draw Cars Like a Pro", Motor Books International, 2006.

19A008 SIGNALS AND SYSTEMS

3 0 0 3

SIGNALS AND SYSTEMS INTRODUCTION : Introduction – Continuous Time (CT) and Discrete Time (DT) signals – Signal operations - Basic CT & DT signals - Representation of signals using impulse function – Classification of CT & DT signals – CT & DT Systems – Basic System Properties (9)

LINEAR TIME INVARIANT SYSTEMS : Discrete time LTI systems - Convolution Sum – Continuous time LTI systems: Convolution Integral – Properties of LTI systems – Unit step response of an LTI system – LTI systems described by linear constant - coefficient differential and difference equations (9)

FOURIER ANALYSIS OF CT SIGNALS AND SYSTEMS : Response of LTI systems to complex exponentials - Representation of CT periodic signals by Continuous Time Fourier Series (CTFS) – Convergence of CTFS – Properties of CTFS - Representation of CT aperiodic signals by Continuous Time Fourier Transform (CTFT) – Convergence of CTFT – Fourier transform for CT periodic signals - Properties of CTFT - Frequency response of systems characterized by linear constant - coefficient differential equations (11)

SAMPLING : Representation of CT signal by samples – Impulse train sampling – Zero order hold sampling – Reconstruction of CT signal from samples - Effect of under sampling – Aliasing (7)

FOURIER ANALYSIS OF DT SIGNALS AND SYSTEMS : Representation of DT periodic signals by Discrete Time Fourier Series (DTFS) - Properties of DTFS - Representation of DT aperiodic signals by Discrete Time Fourier Transform (DTFT) – Convergence of DTFT – Fourier transform for DT periodic signals - Properties of DTFT - Frequency response of systems characterized by linear constant - coefficient difference equations (9)

Total L: 45

TEXT BOOKS:

1. Alan V Oppenheim, Alan S Wilsky, and S Hamid Nawab , "Signals and Systems", 6th Edition, PHI Learning Private Limited, New Delhi, 2014.
2. Dimitris G Manolakis and Vinay K .Ingle , "Applied Digital Signal Processing Theory and Practice", 4th Edition, Cambridge University Press, Cambridge University, 2011.

REFERENCES:

1. Simon Haykin and Barry Van Veen , "Signals and Systems", 5th Edition, John Wiley, New Delhi, 2012.
2. Samir S Soliman and Srinath M D , "Signals and Systems", 6th Edition, PHI, New Delhi, 2010.
3. Lathi B P , "Linear Systems and Signals", 4th Edition, Oxford University Press, Chennai, 2010.

19A009 AUTOMOTIVE INSTRUMENTATION

3 0 0 3

INTRODUCTION TO TRANSDUCERS AND SENSORS : Transducers- types-resistive, capacitive and inductive based sensors with linear transfer characteristics- thermistor- LVDT- inductive pickup- capacitance- strain gauges- semiconductors- piezoelectric accelerometer- proximity sensors- micro switches-encoders- piezoelectric pressure sensors- instruments- ammeter- voltmeter- speedometer--pressure gauge- vacuum gauge- analog and digital- calibration- cathode ray oscilloscope. (9)

AMPLIFIERS AND SIGNAL CONDITIONING CIRCUITS : Analogue signal acquisition with operational amplifier circuits basics- analysis of operational amplifiers circuits - selected examples of basic circuits (Amplifier - Integrator - Adder - Sign Switch - Comparator and Schmitt Trigger) - digital signal acquisition- theory of digital to analog and analog to digital conversion- DAC principles- ADC circuits- recorders- signal conditioning and filtering. (9)

VEHICLE INSTRUMENT CLUSTER : Typical INS cluster- analog and digital dash instruments – speedometer – odometer – warning - temperature – pressure – ABS – signaling circuits – seat belt restrainer – fuel level – Tyre pressure monitoring – infotainment and telematics – overview- diagnostic trouble codes (DTC) – on-board diagnostics (OBD). (9)

VEHICLE SERVICING INSTRUMENTATION : Wheel alignment gauges - laser alignment- exhaust gas analyzer- emission norm standards - flasher instrumentations - wheel balancing – calibrations- dynamometer- starter motor- dynamometer calibrations - fuel ignition calibration - ignition timer calibration – stroboscope- tachometer- tyre air pressure instrument- head light alignment - head light intensity study- smoke meter- macro inspection of interior parts using fiber optics-boroscopes (9)

NVH INSTRUMENTATION : Sound level meters - acoustic measurement - FFT analyzer- anechoic chamber- varechoic chamber- sound level measurements- NVH standard- accelerometers - Triaxial sensors. (9)

Total L: 45

TEXT BOOKS:

1. Ernest O Doebelin , "Measurement systems – Application and Design", McGraw Hill publishing company, 2010.
2. Halderman J , "Diagnosis and Troubleshooting of Automotive Electrical, Electronics and Computer Systems", Pearson Education, Professional Technical Series, 2012.

REFERENCES:

1. Beakwith T G, Buck N L , "Mechanical Measurements", Pearson Education, New Delhi, 2007.
2. Jurgen R , "Automotive Electronics Handbook", McGraw Hill, New York, 2000.
3. Tom Denton , "Advanced Automotive Fault Diagnosis", Elsevier Butterworth-Heinemann, 2006.

19A010 AUTOMOTIVE TESTING

3 0 0 3

VIBRATION AND BODY TESTING : Vibration measurement instrument – accelerometer and signal conditioning - graphical presentation. Dynamic simulation sled testing - methodology - vehicle acceleration measurement and documentation. Dolly roll

over test - dolly role over fixture - photographic / video coverage - instrumentation. Vehicle roof strength test – test procedure and test measurements. Door system crush test – procedure and measurements. (9)

SUSPENSION AND STABILITY FOR DIRECTIONAL CONTROL : Measurement of dimensional and geometric characteristics - measurement of centre of gravity position - measurement of moments and products of inertia - measurement of suspension kinematic characteristics - measurement of suspension elastic and coulomb friction characteristics - measurement of shock absorber characteristics. (9)

STEERING SYSTEM FOR DIRECTIONAL CONTROL : Analysis of constant radius test - constant steer angle test - constant speed variable radius test - constant speed variable steer angle test - response gain test. (9)

CORNERING AND WHEEL TESTING : Dynamic cornering fatigue - dynamic radial fatigue tests – procedure - bending moment and radial load calculations. Impact test – road hazard impact test for wheel and tyre assemblies - test procedures - failure criteria and performance criteria. Bumpers - types of tests - pendulum test - fixed collision barrier test - procedure - performance criteria. (9)

BRAKING PERFORMANCE TESTING : Air and hydraulic brake test - air brake actuator - valves test – performance requirements. Parking brake – drawbar pull test - grade holding test. (9)

Total L: 45

TEXT BOOKS:

1. Crouse W.H, Anglin D.L , "Automotive Mechanics", Tata McGraw Hill Publishing Company, 2004.
2. Rangan, Mani, Sharma , "Instrumentation", Tata McGraw Hill Publishers, New Delhi, 2009.

REFERENCES:

1. SAE Hand book , "Hand book", SAE Publications, 2000.
2. Jain R K. , "Mechanical and Industrial Measurements", Khanna Publishers, New Delhi, 1999.
3. Tim Giles , "Automotive Service", Delmar Publishers, 1998.
4. Beckwith TG, Buck N L , "Mechanical Measurements", Addition Wesley Publishing Company Limited, 1995.

19A011 AUTOMOTIVE PRODUCT LIFE CYCLE MANAGEMENT

3 0 0 3

MOTIVATION AND INTRODUCTION : E-commerce - B to B - B to C forms of business - Extended enterprise - Concepts in PDM - product life cycle - Business objects - Work flows - Versions - Views - Product structure - Change processes - Work list - Information flow model in product development - Engineering bill of materials and manufacturing BOM. (9)

COMPONENTS OF PLM SOLUTIONS : Object oriented approach in product development solutions - Phase gate process in product design - disparate databases and connectivity - Use of EAI technology (middleware) - Cases for preparation of combined BOM and other reports - Component supplier management and sourcing. (9)

PRODUCT VISUALISATION : CAD neutral environment and visualization of products - Standard software - Use of visualization in several stages of lifecycle - Reviews - Mark up - case studies. (9)

ROLE OF PLM IN INDUSTRIES : Automotive sectors - Ten step approach to PLM - Benefits of PLM. (9)

DETAILS OF MODULE : Details of modules in a PDM/PLM software - Basics on customization and implementation of automotive PDM/PLM software. (9)

Total L: 45

TEXT BOOKS:

1. Stark John , "Product Lifecycle Management (Volume 1)", 4th Edition, Springer International Publishing, 2019.
2. Antti Saaksvuori, "Product Lifecycle Management", 3th Edition, Springer International Publishing, 2010.

REFERENCES:

1. Wang Lihui, Andrew Y C N , "Collaborative Design and Planning for Digital Manufacturing", Springer-Verlag London Limited, 2009.
2. Grieves Michael , "Product Life Cycle Management", 2nd Edition Tata McGraw Hill, 2006.

19A012 VIBRATION AND NOISE ENGINEERING

3 0 0 3

VIBRATION FUNDAMENTALS AND INSTRUMENTATION TECHNIQUES : Introduction - elements of vibration - types of vibration - Undamped & damped vibrations - Vibration transducers - transducer working principle - transient and steady state response of one degree of freedom system applied to vehicle systems - multi degree of freedom system (MDOF) - FFT analyser. (12)

SOURCES OF VIBRATION : Introduction - engine vibration- transmissibility- design of engine mounts – resonance and determination of natural frequencies and modes shapes- loss factor -loss modulus and storage modulus of damping material - damper requirements (8)

NOISE FUNDAMENTALS AND INSTRUMENTATION TECHNIQUES : Sound propagation - quantification of sound - frequency and wave length - sound pressure level , free field and far field - sound intensity level - vehicle noise specifications & standards - noise induced hearing losses. Exterior noise sources - Interior noise sources. Microphones & calibrators - Excitation devices - frequency analysis - sound pressure measurement - sound intensity measurement - sound intensity probes - data acquisition system - digital signal processing - semi-anechoic rooms. (9)

NOISE ANALYSIS AND CONTROL METHODS : : Transfer Path Analysis: single source structure-borne noise transmission path analysis - multiple reference transmission path analysis - Impedance modeling - modal analysis: definition of modal properties - modal analysis theory- determination of mode shapes of vehicle cabin - passive noise control methods: ducts & mufflers -types of mufflers - performance parameters – acoustics and backpressure - reactive and absorptive silencers - helmholtz resonators and side branch resonators (8)

DESIGN OF SOUND ABSORBERS : Introduction- different noise control material- Impedance tube testing – Delany –Bazely method – Transfer matrix method to determine TL- Green material used for sound absorption (8)

Total L: 45

TEXT BOOKS:

1. Mathew Harrison , "Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles", 2nd Edition, SAE International, USA, 2013.
2. Munjal M.L , "Acoustics of Ducts and Mufflers", 3rd Edition, John Wiley, UK, 2011.

REFERENCES:

1. Rajesh Rajamani , "Vehicle Dynamics and Control", 2nd Edition, Springer, 2011.
2. Xu Wang , "Vehicle noise and vibration refinement", 3rd Edition, Wood Head Publishing, 2012.

19A013 VEHICLE DEVELOPMENT PROCESS

3 0 0 3

VEHICLE DEVELOPMENT PROJECTS : Categories of vehicle development projects - platforms and model lines - the product evolution process - vehicle project management - aspects of international development projects – cars that topped and cars that flopped - factors of success in the automotive industry. (9)

VIRTUAL CAR PROCESS : Building virtual cars - geometric integration - further functional geometry evaluation - virtual build groups - E/E system development: from machinery to E/E systems - systems engineering processes. (9)

MANAGEMENT PROCESSES FOR COMPLETE VEHICLE DEVELOPMENT : Target management - design problemmanagement - release and change management and quality management. (9)

CUSTOMER RELEVANT COMPLETE VEHICLE CHARACTERISTICS : Registrability - total vehicle costs – design appeal - cabin comfort - infotainment - passive safety. (9)

SECONDARY COMPLETE VEHICLE CHARACTERISTICS : Production integration - service integration. (9)

Total L: 45

TEXT BOOKS:

1. Weber Julian , "Automotive Development Processes", Springer, 2009.
2. Daniel Sörensen , "The Automotive Development Process", Springer, 2006.

REFERENCES:

1. John Stark , "Global Product", Springer Publisher, 2007.
2. Tony Lewin, Ryan Borroff , "How to Design Cars Like a Pro", Motor Books International, 2010.
3. Stuart Macey, Geoff Wardle, Ralph Gilles, Freeman Thomas, Gordon Murray , "H-Point: The Fundamentals of Car Design and Packaging", Design Studio Press, 2009.

19A014 MATHEMATICAL MODELING OF MECHANICAL SYSTEMS

3 0 0 3

PRINCIPLES OF MATHEMATICAL MODELING OF MECHANICAL SYSTEMS : Introduction-Mathematical Modeling- Bars Under Axial Vibration- Bars Under Torsional Vibration Beams Under Flexural Vibration- Systems Governed by Second-

Order PDEs- Properties of the Laplace Transform- Time Response via the Laplace Transform- The Inverse Laplace Transform- The Final and the Initial-Value Theorems. (9)

VIBRATION ANALYSIS OF TWO-DOF SYSTEMS : Constitutive Equations of Mechanical Elements- springs and dashpots – series and parallel arrays –Hysterical Damping- Coulomb damping-The Derivation of the Governing Equations-Equilibrium States-Linearization of the Governing Equations- Lagrange Equations of Linear Mechanical Systems. Introduction-Natural Frequencies and the Natural Modes-The Zero-Input Response of Two-DoF Systems. (9)

STEERING SYSTEM AND ROAD MODELING : Steering system forces and moments calculation- EPS motor torque requirement and influence different parameters – parking torque estimation- dynamics of rack and pinion steering–concept of road modeling - Deterministic Profiles –Random profiles. (9)

SUSPENSION AND TIRE MODELING : Quarter car model - Kinematics of a Double Wishbone Suspension - Modeling Aspects - Constraint Equations - Spring Damper in Series tire modeling- – Pacejaka magic formula- brush and Dugoff model- Introduction to full car model with 16 DoF. (9)

MATHEMATICAL MODELING OF ELECTROMECHANICAL SYSTEMS : Mathematical models of DC servomotors - Mathematical Modeling of Operational-Amplifier Systems - Mechanical-Electrical Analogies: Force-voltage analogy -Force-current analogy-Mathematical Modeling of Liquid-Level Systems (9)

Total L: 45

TEXT BOOKS:

1. Van Den Bosch , "Modeling, Identification and Simulation of Dynamical systems", 4th Edition, CRC press, 2014.
2. Van Der Klauw and Alan Shearer , "Dynamic Modeling and Control of Engineering", 2nd Edition, Springer and Verlog, 2015.

REFERENCES:

1. Guillaume Dubois , "Modeling and Simulation: Challenges and Best Practices for Industry", 1st Edition, CRC press, 2012.
2. Francois Axisa, Jose Antunes , "Modeling of Mechanical Systems: Fluid-Structure Interaction", 3rd Edition, Elsevier, 2015.

19A015 MODEL BASED DESIGN

3 0 0 3

VEHICLE MODELING : Introduction to MBD- Quarter car –half-car and full car mathematical model-Governing differential equations -Development of SIMULINK model. (9)

SUSPENSION SYSTEM MODELING : Introduction- semi-active and fully active suspension system modeling – preview control suspension system – mathematical modeling of dampers and air springs-Development of SIMULINK model. (9)

STEERING SYSTEM MODELING : Introduction- steering torque computation based on steering geometry and wheel alignment- EPS motor model – Electrically powered hydraulic steering model.-Development of SIMULINK model. (9)

MODEL IN-LOOP SIMULATION : Introduction- Model in-loop simulation- software in loop simulation-processor in loop simulation concepts –V and V testing. (9)

HARDWARE IN LOOP SIMULATION(HILS) : Introduction- HILS- case studies- integration of SILS and HILS.- HILS test bench basics, (9)

Total L: 45

TEXT BOOKS:

1. Manfred Hiller, Roberto Bardini , "Vehicle dynamics – Modeling and Simulation", 2nd Edition, Springer, 2013.
2. Ann Eriksson, John Nielsen , "Modeling and control of Engines and Drivelines", 3rd Edition, John Wiley and Sons, 2014.

REFERENCES:

1. Galip Ulsoy, Huei Peng , "Automotive Control systems", 2nd Edition, Cambridge University press, 2012.
2. Nicolas Navet, Françoise Simonot-Lion , "Automotive Embedded Systems Handbook", 3rd Edition, CRC press, 2016.

19A016 SURFACE FINISHING PROCESS

3 0 0 3

METAL CLEANING AND PREVIEW ON SURFACE ENGINEERING : Need and relevance of surface engineering - pretreatment of coating. General cleaning process for ferrous and non ferrous metals and alloys - selection of cleaning process – alkaline cleaning – emulsion cleaning - ultrasonic cleaning – acid and pickling salt bath descaling - abrasive bath cleaning - polishing and shot peening - classification of surface engineering processes. (9)

THERMAL SPRAYING PROCESSES AND ELECTRODEPOSITED COATINGS : Thermal spraying – flame, arc, plasma and HVOF processes – PLV process - design for thermally sprayed coatings - coating production - spray consumables principles of electroplating - Technology and control electroplating systems - properties and Faraday's Law - factors affecting throwing power - Applications of electrodeposites - non-aqueous and electroless deposition. (9)

HOT DIP COATING AND DIFFUSION COATINGS : Principles – surface preparation batch coating and continuous coating process – coating properties and applications - Principles of cementation - cladding - Diffusion coating of C.N. Al, Si, Cr and B - structure, properties and application of diffusion coatings - chemical vapour deposition - physical vapour deposition. (9)

NON-METALLIC COATING OXIDE AND COVENTSION COATINGS : Plating coating – laequers - rubbers and elastomers - vitreous enamels - anodizing phosphating and chromating - application to aluminium, magnesium, tin, zinc, cadmium copper and silver - phosphating primers. (9)

QUALITY ASSURANCE, TESTING AND SELECTION OF COATINGS : The quality plan – design - testing and inspection of thickness adhesion - corrosion, resistance and porosity measurement - selection of coatings - industrial applications of engineering coatings. - Basic mechanisms of wear - abrasive, adhesive wear, contact fatigue - fretting corrosion - testing wear resistance practical diagnosis of wear. (9)

Total L: 45

TEXT BOOKS:

1. S. Grainger, J. Blunt , ""Engineering coatings - design and application"", 2nd Edition, Abington Publishing, Woodhead Publishing Ltd, England, 2008
2. P. A. Dearnley , ""Introduction to Surface Engineering"", 1st Edition, Cambridge University Press, USA, 2017.

REFERENCES:

1. Parthasarathy. N.V , ""Electroplating Handbooks", Prentice Hall, 1992.
2. Gabe. D.R. , ""Principles of Metal surface treatment and protection", Pergamon, 1990.
3. Niku-Lavi , ""Advances in surface treatments"", Pergamon, 1990. ASM, 1994.

19A017 INTERNET OF THINGS

3 0 0 3

INTRODUCTION : Industrial revolution - Germany's leadership role - digitalization as a megatrend - Industry 4.0 - smart products - smart engineering - platforms and ecosystems - artificial intelligence - big data - the cloud - reference architecture - standardization - projects in practical application. - intelligent worker assistance systems. (9)

EFFICIENT FACTORY : Applications - components and operating - materials as information carriers – paperless quality assurance - digital value stream mapping - status and energy monitoring - flexible. (9)

THE INDUSTRIAL INTERNET : Demands to a modern product development process - industrial internet - PLM to SysLM - demands to SysLM solutions. (9)

INDUSTRIE 4.0 - DIGITAL REDESIGN OF PRODUCT CREATION AND PRODUCTION : Projects at the production technology center - industrial information technology as the metronome of Industrie 4.0 - information factories. (9)

THE INTERNET OF THINGS, SERVICES AND PEOPLE : The “intelligence” of machines - shifting system barriers – data enables integrated operations - data scientists and process knowledge - step by step to the IoTSP. (9)

Total L: 45

TEXT BOOKS:

1. Ulrich. S , "The Internet of Things: Industrie 4.0 Unleashed", Springer-Verlag, 2018.
2. Jeschke S, Brecher C, Song H, Rawat D B , "Industrial Internet of Things: Cybermanufacturing Systems", Springer, 2017.

REFERENCES:

1. Stark John , "Product Lifecycle Management (Volume 1)", Springer International Publishing, 2015.
2. Alasdair Gilchrist , "The Industrial Internet of Things", Apress, 2016.

3. Sabina Jeschke, Christian Brecher, Houbing Song, Dana B. Rawat , "Industrial Internet of Things: Cyber- manufacturing Systems", Springer, 2017.

19A018 ARTIFICIAL INTELLIGENCE

3 0 0 3

INTRODUCTION : Artificial Intelligence - history - the state of the art - intelligent agents - structure - environment. (5)

SEARCH STRATEGIES : Breadth - first Search - uniform cost search - depth - first search - depth - limited search - iterative deepening search - bidirectional search - heuristic search techniques - A* Search - AO* Algorithm - adversarial search: Minimax algorithm - Alphabeta pruning. (12)

KNOWLEDGE AND REASONING : Representation - first order predicate logic – inference – unification - forward and backward chaining - resolution - reasoning with default information - truth maintenance systems - acting under uncertainty - statistical reasoning - probability and bayes theorem - certainty factors and rule based systems – dempster. (10)

PLANNING AND LEARNING : Planning with state space search: partial order planning - planning graphs - Examples. forms of learning: inductive learning - explanation based learning - statistical learning - learning with complete data. (10)

NATURAL LANGUAGE PROCESSING : Phrases - syntactic processing - semantic analysis - discourse and pragmatic processing (8)

Total L: 45

TEXT BOOKS:

1. Stuart J Russell and Peter Norvig , "Artificial Intelligence - A Modern Approach", Fifth, Pearson Education, New Delhi, 2015.
2. Elaine Rich and Kevin Knight , "Artificial Intelligence", Third, Tata McGraw Hill Publishing Company, New Delhi, 2014.

REFERENCES:

1. Dan W Patterson , "Introduction to AI and Expert Systems", Fourth, Prentice Hall of India, New Delhi, 2010.
2. Eugene Charniak and Drew McDermott , "Introduction to Artificial Intelligence", Fifth, Pearson Education, New Delhi, 2010.
3. Nils J Nilsson , "Principles of Artificial Intelligence", Fourth, Narosa Publishing House, New Delhi, 2011.

19A019 INTRODUCTION TO DIGITAL SIGNAL PROCESSING

3 0 0 3

DISCRETE-TIME SIGNALS AND SYSTEMS : Need and benefits of Digital Signal Processing –Signal classification and basic operations on them – LTI system –Impulse response - Convolution sum and Correlation - I/O relationship - determination of Impulse response and Step response using Z transformation - A Typical DSP system. (9)

DISCRETE TRANSFORMS : Fourier Series and Fourier Transform - Discrete Fourier Transform (DFT) - Properties – DIT - FFT and DIF - FFT radix2 algorithms - linear filtering via circular convolution - inverse FFT (9)

DESIGN OF IIR DIGITAL FILTERS : Characteristics and applications of IIR filters - Design techniques for analog filters - frequency transformation - Digital IIR filter design: impulse invariant and bilinear transform methods – Canonical forms of Realization : direct, cascade, and parallel forms. (9)

DESIGN OF FIR FILTERS : Characteristics and applications of FIR filters - FIR filter design using Window functions - Canonical forms of Realization. Finite Word Effects- A/D quantization noise – Product round off errors - Finite word length effects in IIR filters and FFT algorithms - Computer architectures for signal processing – pipelining - hardware multiplier – accumulator - special instructions - extended parallelism : SIMD, VLIW, and super scalar processing. (9)

GENERAL-PURPOSE DIGITAL SIGNAL PROCESSORS : Computer architectures for signal processing – pipelining - hardware multiplier – accumulator - special instructions - extended parallelism : SIMD, VLIW, and super scalar processing (9)

Total L: 45

TEXT BOOKS:

1. Lonnie C Ludeman , "Fundamental of Digital Signal Processing", Wiley, New Delhi, 2011.
2. Emmanuel C Ifeachor, Barrie W Jervis , "Digital Signal Processing, A practical approach", Pearson Education, New Delhi,2012.

REFERENCES:

1. John G Proakis , "Digital Signal Processing : Principles , Algorithms, and Applications", Pearson Education, New Delhi, 2012.
2. Sanjit K Mitra , "Digital Signal Processing, A Computer based Approach", Tata McGraw-Hill, New Delhi, 2010.

19A020 MOBILITY AND INFRASTRUCTURE**3 0 0 3**

MOBILITY : Need for sustainable personal mobility - combination of transformative ideas - implementation. (9)

THE NEW DNA OF THE AUTOMOBILE : The evolution of the automobile and its DNA - emerging problems and opportunities - synergies between electrification and connectivity - the emerging personal mobility revolution. (9)

THE MOBILITY INTERNET : Networked computing and control - trip times and congestion - dedicated smart vehicle lanes - new driving and riding experiences. (9)

REINVENTING THE AUTOMOBILE FOR URBAN USE : Limitations of existing vehicle designs for urban use - the simplicity of battery-electric vehicles - emerging vehicle concepts - personal urban mobility and accessibility - affordability. (9)

CLEAN, SMART ENERGY SUPPLY : New energy supply chains for automobiles - the complementary nature of electricity and hydrogen - the effects of energy density - the opportunity of evolving battery technology – design requirements for a charging infrastructure - potential electrification of roadways. (9)

Total L: 45**TEXT BOOKS:**

1. William J. Mitchell, Bruce E. Hainley, Lawrence D. Burns , "Reinventing the Automobile – Personal Urban Mobility for the 21st Century", MIT Press, 2015.
2. Venkat Sumantran, Charles Fine, David Gonsalvez , "Faster, Smarter, Greener - The Future of the Car and Urban Mobility", MIT Press, 2017.

REFERENCE:

1. John Stark , "Global Products", Springer-Verlag London Ltd, 2007.
2. Sabina Jeschke, Christian Brecher, Houbing Song, Dana B. Rawat , "Industrial Internet of Things: Cyber- manufacturing Systems", Springer, 2017.

19A021 VIRTUAL PRODUCT DEVELOPMENT**3 0 0 3**

VIRTUAL REALITY TECHNOLOGY : A concept for a multipurpose - multi-modal interface for product engineering applications - virtual reality systems - Haptic systems - fully-isotropic parallel mechanisms - collision detection - virtual mechanisms. (9)

VIRTUAL REALITY AIDED DESIGN : Concept - framework - hand motions in conceptual shape design - use of VR in automotive industry. (9)

VIRTUAL TESTING AND PROTOTYPING : Modeling - simulation and visualization - virtual prototyping of automotive -virtual and real testing of products. (9)

VIRTUAL MANUFACTURING : Automated design analysis - assembly planning and motion - analysis of design and manufacturing tasks using Haptic and immersive. (9)

CASE STUDIES : Applications in automobile engineering. (9)

Total L: 45**TEXT BOOKS:**

1. Talaba Doru, Amditis Angelos , "Product Engineering Tools and Methods Based on Virtual Reality", Springer, 2008.
2. Alan B Craig, William R Sherman, Jeffrey D Will , "Developing Virtual Reality Applications: Foundations of Effective Design", Morgan Kaufmann, 2009.

REFERENCES:

1. Tom Dieck M Claudia, Jung Timothy , "Augmented Reality and Virtual Reality", Springer, 2018.

19A022 MOTOR TRANSPORT**3 0 0 3**

MODES OF TRANSPORT AND TRANSIT OPERATION : Modes of transport - road transport - Types of roads - advantages - motor transport in India. Route planning - Route location - stop location - route schedules – vehicle and labor scheduling. Traffic control - Traffic signals - signal timing. (9)

COSTS & FARES : Operating costs and types of vehicles - types of fare structure - types of fare collecting methods - Requirement of buses and frequency - construction of bus station. (9)

FORMS OF OWNERSHIP : Sole proprietorship - partnership - private limited company - public limited company - statutory company - local authority undertaking / municipal transport company - joint venture. (9)

GARAGE MANAGEMENT AND VEHICLE MAINTENANCE : Garage administration - types of garages - one spanner - two spanner - three spanner - break down truck symbol - government approved workshops – Tools- Objectives of maintenance - breakdown maintenance - preventive maintenance - tyre maintenance tips and failures. Fuel saving techniques and fitness certificate (9)

LEGAL ASPECTS : Motor vehicle act 1988 - Registration - necessity of permits - insurance - test of competence to drive - mistake / offences for which a driver can be punished - adult workers - Hours of work - running time – split duty - journey time - round journey time - layover - frequency (9)

Total L: 45**TEXT BOOKS:**

1. John Dolu, Manage , "Fleet management", McGraw-Hill Co, 2009.
2. Crouse, William H, Anglin, Donald L , "Automotive Mechanics", McGraw-Hill Companies, 2007.

REFERENCES:

1. Government Publication , "The Motor vehicle Act 1988", 1988.
2. Kitchin L.D , "Bus operation", Illiffe and Sons Ltd, London, 1992.
3. Gilles, Tim , "Automotive Service – Inspection, Maintenance, and Repair", Alar Elken Publications, 2007.
4. Khanna O.P , "Industrial Engineering and Management", Dhanpat Rai Publications, 2010.

19A023 SOLAR VEHICLES**3 0 0 3**

INTRODUCTION : Solar constant - solar time - angle of incidence - design of method - isotropic - transmittance - diffuse radiation - solar radiation - Measuring Sunlight - Sunlight Emulation - collecting sunlight (9)

PHOTOVOLTAIC CELLS : Photoelectric effect - metals, semiconductors, insulators - absorption of light - doping - drift current - diffusion current - semiconductor resistivity - semiconductor fundamental equations - the Poisson's equation - continuity equation - Photoelectric effect - metals, semiconductors, insulators - absorption of light - doping - drift current - diffusion current - semiconductor resistivity - semiconductor fundamental equations - the Poisson's equation - continuity equation (9)

DESIGN AND CONTROL OF DC-AC INVERTERS : Boost converters - MPPT - perturb and observe algorithm - incremental conductance - neutral point clamp - multi level inverter - active and reactive power control - multi level inverter. Solar electric drive - losses (9)

SMART-GRID INTERACTION WITH ELECTRIC VEHICLES : Electric Vehicle Integration with a Smart Grid – Electric Vehicle Integration with Renewable Energy - V2G: Impact, Potential, and Challenges (9)

SOLAR VEHICLE INSTRUMENTATION : Current - voltage - temperature - speed - battery charge - radiation - instrument panel - telemetry - solar Racer—concept generation and selection (9)

Total L: 45**TEXT BOOKS:**

1. Springer International Publishing, Vancouver, 2015.
2. Gary B,Erickson J, Eugene L, Robinson and Jessica , "Solar Powered Charging Infrastructure for Electric Vehicles: A Sustainable Development", First, CRC, New York, 2017.

REFERENCES:

1. Seba T , "Solar Trillions", beta edition, Tony Seba, Cincinnati, 2014. Taylor & Francis, New York, 2015.
2. Hayes.G and Goodarzi , "Electric Powertrain- Energy systems, power electronics and drives", First, Jhon Wiley, Sussex, 2018.

19A024 VEHICLE COMMUNICATION SYSTEMS

3 0 0 3

AUTOMOTIVE COMMUNICATION SYSTEMS : Introduction to Bluetooth – Pairing - HFP - A2DP - PAN - PBAP - DUN. Concepts of MOST network - DLNA - AVB. Concepts of TCP/IP - Ethernet - WiFi - WiFi Direct - MyWiFi and CAN - Mirror link - Tethering. (9)

INFOTAINMENT SYSTEMS FUNDAMENTALS : Introduction to In Vehicle Infotainment (IVI) systems - Use of operating systems in IVI - GENIVI Alliance-Tuner- AM/FM - XM/Sirrus - DAB/DMB - Software Defined Radio - Ensemble - Traffic Announcements - Spread Spectrum-Multimedia: Types of Media. Navigation- Points of Interests - Routes - Waypoints - Dead Reckoning position - Traffic Info - GLONASS - GNSS - RTK - GPS - and SBAS/GBAS - INS - System Architecture – Design Patterns - Proxies - Adaptors - Interfaces - Singleton - Factory method. (9)

TELEMATICS AND SECURITY SYSTEMS : Telematics-Global positioning systems - geographical information systems - navigation systems - automotive vision system - road recognition - driver assistance systems. Security Systems- Vehicle Immobilizers - Anti theft technologies - smart card system - number plate coding. (9)

COMFORT SYSTEMS : Introduction - driver support systems – driver information - driver perception - driver convenience - driver monitoring. Vehicle support systems – general vehicle control - collision avoidance - vehicle status monitoring -HMI Systems-collapsible and tilt table steering column - power windows - X-by wire technologies-Steer by wire system - Brake by wire system and Drive by wire system (9)

ADVANCED DRIVER ASSISTANCE AND SAFETY SYSTEM : Active Safety Systems -and Passive Safety Systems - Advanced Driver Assistance Systems (ADAS)-Combining computer vision techniques as pattern recognition - feature extraction - learning - tracking - 3D vision to assist the driving activity. Examples of assistance applications- Lane Departure Warning - Collision Warning - Automatic Cruise Control - Pedestrian Protection – Headlights Control - Connected Cars technology and trends towards Autonomous vehicles. (9)

Total L: 45

TEXT BOOKS:

1. William B Ribbens , "Understanding Automotive Electronics", Butter worth Heinemann Woburn, 2012.
2. Yunpeng Wang, Daxin Tian, Zhengguo Sheng, Wang Jian , "Connected Vehicle Systems: Communication, Data, and Control", 2nd Edition , CRC publisher, 2017.

REFERENCES:

1. Dennis Foy , "Automotive Telematics", Red Hat Publishers, 2002.
2. Markus Mueck, Ingolf Karls , "Networking Vehicles to Everything: Evolving Automotive Solutions", DEG Press, 2018.

19A025 AUTOMOTIVE STYLING

3 0 0 3

VISION : Identifying opportunity - defining a vision - setting targets - opportunities in portfolio - research examples of personal - design manifesto and design movements - spreading the word and generating a mission statement - understanding the interplay between brand and design brief - creating a design brief. (9)

IDEATE : Explore various vehicle packages and technical solutions based on the needs of target customer and market opportunity - structure and a framework for vehicle architecture - explore unique visual DNA for a vehicle based on objectives - begin to explore surface language - selecting key directions and identifying themes - understanding segmentation and competitive benchmarking. (9)

DEVELOP : Character development and processing imagery - establishing an architectural and visual foundation - design development in full-size - refining proposals and making a final selection - creating an initial design prototype - final theme selection. (9)

MODEL : Virtual 3D and the digital design process - digital sketch modeling - 3D data development – rapid validation mockups. (9)

BUILD AND LAUNCH : Vetting an idea - engineering - processing - market research - early-stage vetting for designers - presenting to clients management and key stakeholders - pitching to prospective users - selling new viewers on an idea - launching a vehicle. (9)

Total L: 45

TEXT BOOKS:

1. Jordan Meadows , "Vehicle Design: Aesthetic Principles in Transportation Design", Taylor & Francis Group, 2018.
2. Tony Lewin, Ryan Borroff , "How to Design Cars Like a Pro", Motor Books International, 2010.

REFERENCES:

1. Thom Taylor , "How to Draw Cars Like a Pro", Motor Books International, 2006.
2. Stuart Macey, Geoff Wardle, Ralph Gilles, Freeman Thomas, Gordon Murray , "H-Point: The Fundamentals of Car Design & Packaging", Design Studio Press, 2009.
3. Erik Olofsson, Klara Sjölen , "Design Sketching", Keeos Design Books AB, 2005.
4. Alan Pipes , "Drawing for Designers", Laurence King Publishing, 2007.

19A026 ELECTRIC VEHICLE DESIGN

3 0 0 3

BEVS DYNAMICS, POWERTRAIN COMPONENT MODELING, AND HEAT TRANSFER MODELLING : Battery electric vehicle (BEV) powertrain - Vehicle dynamics - Vehicle dynamics - Transmission - auxiliary loads - Electric Vehicle Chassis and Body Design - Body/Chassis Requirements - Layout - Strength, Rigidity and Crash Resistance - Designing for Stability - Suspension for Electric Vehicles - Chassis used in Modern Battery and Hybrid Electric Vehicles (12)

DRIVE DESIGN FOR EVS : Different drives - induction machines - BLDC –SRM motors - constant power - constant torque regions - Number of phases - Frequency - Rated output in kW - Type of duty - Voltage connections - Temperature rise - Speed - Pullout torque - Starting torque - Starting current - Power factor - Efficiency/losses -Class of insulation (10)

ELECTRIC MOTOR AND DRIVE TRAIN CONTROLLER DESIGN : Brushless motor design considerations – innovative drive scheme - motor cooling - efficiency - size and mass - improving motor efficiency (8)

ENERGY STORAGE MODELLING : Purpose of Battery Modelling - Equivalent Circuit - Modelling Battery Capacity - Simulating a Battery at a Set Power - Calculating the Peukert Coefficient - Approximate Battery Sizing – Battery Swapping (7)

DESIGN OF ANCILLARY SYSTEMS : Heating and Cooling Systems - Design of the Controls - Power Steering - Choice of Tyres - Wing Mirrors, Aerials and Luggage Racks (8)

Total L: 45

TEXT BOOKS:

1. Larmine J and Lowry J , "Electric Vehicle Technology Explained", First, John Wiley & Sons, Vancouver, 2012.
2. Hayes.G and Goodarzi , "Electric Powertrain- Energy systems, power electronics and drives", First, Jhon Wiley, Sussex, 2018.

REFERENCES:

1. Mi Chris and Masur Abul , "Hybrid electric vehicles", 3rd Edition, John Wiley, 2018.
2. Liu Wei , "Introduction to Hybrid vehicle systems Modeling and Control", 1st Edition, John Wiley, 2017.

19A027 POWER TRAIN DESIGN (ELECTRIC AND HYBRID)

3 0 0 3

CONCEPT OF ELECTRIFICATION : Constituents of a conventional vehicle - Vehicle and propulsion load - drive cycles and drive terrain - constituents of a PHEV - vehicle model - EV powertrain component sizing – electrically peaking hybrid concept - gradability Requirement (9)

ADVANCED HEV ARCHITECTURES AND DYNAMICS OF HEV POWERTRAIN : Principle of Planetary Gears - Operating Principle of the Two-Mode Powertrain - Gear Shift Schedule - DCT-Based Hybrid Powertrain - Regenerative Braking Mode - Electric CVT Mode - Energy Recovery Mode (9)

PLUG-IN HYBRID ELECTRIC VEHICLES : Plug-In Hybrid Electric Vehicles - Blended PHEVs - Equivalent Electric Range of Blended PHEVs - Utility Factor - Power Management of PHEVs - Component Sizing of EREVs (9)

MODELING AND SIMULATION OF ELECTRIC AND HYBRID VEHICLES : Fundamentals of Vehicle System Modeling - Hybrid Powertrain Modeling - Modeling of Vehicle Dynamics - Bond Graph Modeling Techniques - Consideration of Numerical Integration Methods. (9)

HEVS COMPONENT SIZING AND DESIGN OPTIMIZATION : Algorithm Description - Flow Chart - Operators and Selection Method - Particle Swarm Optimization - Model-in-the-Loop Design Optimization Process - Genetic Algorithm modelling (9)

Total L: 45

TEXT BOOKS:

1. Mi Chris and Masur Abul , "Hybrid Electric Vehicles", Fourth, John Wiley, Heidelberg, 2018.
2. Liu Wei , "Introduction to Hybrid vehicle systems Modeling and Control", Third, John Wiley, Zurich, 2018.

REFERENCES:

1. Emadi Ali , "Advanced Electric Drive Vehicles", First, Taylor & Francis, New York, 2015.
2. Yangsheng Xu, Huihuan Qian, Jingyu Yan and Tin Lun Lam , "Hybrid Electric Vehicle Design and Control: Intelligent Omnidirectional Hybrids", 1st Edition, McGraw Hill, New York, 2014.

19A028 POWER ELECTRONICS AND DRIVES

3 0 0 3

INDUCTION MOTOR DRIVES : Speed control of 3 phase Induction Motors - Stator control - PWM &V/f control - rotor control: Rotor resistance control - Static control of rotor resistance using DC chopper - Static Kramer and Scherbius drives - Introduction to Vector Controlled Induction Motor Drives (9)

SYNCHRONOUS MOTOR AND BLDC MOTOR DRIVES : Speed control of 3 phase Synchronous Motors - True synchronous and self-controlled modes of operation - PMSM: principle-flux density distribution-Types - BLDC motor : Principle-drive scheme - converter topologies (9)

RELUCTANCE MOTOR DRIVES : DC servo drives -principle of operation - AC servo drives- principle of operation - Stepper motor – principle of operation - SRM drives - principle of operation - drives - Introduction to synRM drives (9)

DIGITAL CONTROL AND DRIVE APPLICATIONS : Digital techniques in speed control - Advantages and limitations - Microprocessor/Microcontroller and PLC based control of drives - networking of drives - Selection of drives and control schemes for Steel rolling mills - Paper mills - Cement mills - Machine tools - Lifts and Cranes. Solar and battery powered drives. (9)

ADVANCED MOTOR DRIVES : Magnetic gear drive- Converted magnetic gears - field modulated magnetic gears - MG Machines- Principle- Modeling- Inverters-MG motor control - Vernier Permanent Magnetic motor- principle - modelling-inverters- PM motor control - Advanced Magnetless motor drives - Planetary-gear electric variable transmission system - double rotor electric variable transmission system (9)

Total L: 45

TEXT BOOKS:

1. Stefanos Manias , "Power Electronics and Motor Drive System", Elsevier, 2010 , .
2. Gonzalo Abad , " Power Electronics and Electric Drives For Traction Applications", 2nd Edition, John Wiley 2012, .

REFERENCES:

1. Krishnan R , "Electric Motor Drives: Modeling, Analysis and Control", Prentice Hall of India, 2013
2. Vedam Subramanyam , "Electric Drives: Concepts and Applications", Tata McGraw-Hill,, 2009

19A029 AUTOMOTIVE COMMUNICATION PROTOCOLS

3 0 0 3

BASICS OF DATA COMMUNICATION NETWORKS AND AUTOMOTIVE COMMUNICATION PROTOCOLS : Need for networks - Types of networks - Need for standards - TCP/IP model - Topologies - Error detection and correction mechanisms - Encoding schemes - Serial/parallel transmission - Bits - Baud and bandwidth - Synchronous and asynchronous - Need and benefits of IVN - Classes of IVN protocols - Multiplexed electrical systems – Vehicle multiplexing - Bitwise contention - Network elasticity - Error processing and management and Case Study (9)

CONTROLLER AREA NETWORK (CAN) PROTOCOL : History and foundation of CAN - CAN Applications - Main characteristics of CAN - CAN in OSI Reference Model - CAN Data Link Layer - Principles of data exchange in CAN - Arbitration - Data Frame - Remote Frame - Error detection and management in CAN - CAN physical Layer - Bit encoding - Bit timing and synchronization - Relationship between data rate and bus length - Single wire and twin wire media - CAN repeaters - Medium-to-medium gateway - Protocol handlers - Micro-controllers and line drivers - TimeTriggered CAN (TTCAN) - Comparison with other IVN protocols - CANoe based applications development (9)

CAN HIGHER LAYER PROTOCOLS AND LIN : CAN Higher Layer Protocols: CAN in Automation (CiA) - CANopen - CANopen device model - CANopen features - DeviceNet - DeviceNet Model - Device Object Model - DeviceNet Features - SAEJ1939 - SAE J1939 Reference Model - CANKingdom and Case Study Local Interconnect Network (LIN) Protocol: Introduction to LIN - LIN consortium - LIN specification - LIN features - Technical overview - Work flow concept - LIN operation - LIN frame format - Scheduling table - Network management of LIN cluster - LIN Transport Layer - LIN node configuration and identification - LIN diagnostics - LIN physical layer - Comparison with other IVN protocols and Case Study (9)

FLEXRAY AND MOST PROTOCOL : FlexRay Protocol: Future on board systems - Need for FlexRay - Origin of FlexRay - FlexRay consortium - FlexRay Objectives - FlexRay Features - Application requirements - Working of FlexRay - Network topologies - FlexRay frame format - Error control - Medium Access Control - Clock Synchronization - Comparison with other IVN protocols and Case Study Media Oriented System Transport (MOST) Protocol: Emerging in car systems - Introduction to MOST - Cables and Connectors - Data Types - Topology - Frame Format - Application Areas - System Description - Specification - Device Model - Device Implementation - Diagnostics and Case Study (9)

IN VEHICLE NETWORK DIAGNOSTICS : Process of Automotive Fault Diagnostics - Fault Codes - Vehicle Systems (open-loop and closed-loop) On- and Off- Board Diagnostics - OBD-I - OBD-II - Engine Analyzers - Steps taken to diagnose a fault - Diagnostics Protocol-KWP2000 - SAE-J1587 - SAE-J1708 and Case Study (9)

Total L: 45

TEXT BOOKS:

1. Gilbert Held , "Inter- and Intra-Vehicle Communications", CRC Press, 2007.
2. Wayne Tomasi , "Introduction to Data communication and Networking", Pearson, 2017.

REFERENCE:

1. Behrouz Forouzan , "Data Communications and Networking", McGraw-Hill, 2007.

19A030 VEHICLE DIAGNOSTIC SYSTEMS

3 0 0 3

INTRODUCTION FAULT DIAGNOSIS : Introduction to fault diagnosis - safe working practices and techniques. Diagnostics on paper - mechanical and electrical diagnostic techniques faults codes - systems and standards. On- and - Off board diagnostics. Data sources - tools and equipments. Oscilloscopes - Scanners/Fault code readers - engine analyzers. Application methods and procedures. (9)

ON AND OFF BOARD DIAGNOSTICS : Introduction to Oscilloscope Diagnostics - Sensors and actuators associated with Oscilloscope Diagnostics - On-Board Diagnostics various perspectives - Petrol/Gasoline On-Board Diagnostics - On-board sensors and actuators - sensors and actuators - comparative case Study. (9)

ENGINE SYSTEM DIAGNOSIS : Introduction to engine systems diagnostics engine operation and fuel system ignition system and emission system fuel injection - Starting and charging system power flow control and energy efficiency analysis. Engine management and fault finding Information. Air supply - exhaust system - cooling and lubrication system. (9)

CHASSIS AND BRAKE SYSTEM DIAGNOSIS : Introduction To engine system diagnostics - Anti-lock braking system diagnostics - Traction control system diagnostics - Steering and tires transmission systems diagnostics - Automobile engineering diagnostics on steering and tires - Case study on diagnostics of sub assemblies. (9)

ELECTRICAL SYSTEMS DIAGNOSIS : Introduction to electronic components and circuits - multiplexing and De multiplexing lighting system faults and auxiliary faults in-car. Entertainment security and communications implementation body-electrical systems - instruments system faults - heating ventilation and air conditioning - Cruise control - air bags and belt tensioners - Cycle test-I - Cycle test-II. (9)

Total L: 45

TEXT BOOKS:

1. Tom Denton , "Advanced Automotive Fault Diagnosis", Elsevier Butterworth-Heinemann linacre House, 2016.
2. Tom Denton , "Automotive Electronics Handbook", 2nd Edition, TATA McGraw-Hill Publishing Co. 2007.

REFERENCES:

1. Routledge , "Automobile Electrical and Electronic Systems", Fourth, 2012.
2. Newnes , "Understanding Automotive Electronics", 6th Edition, 2003.

19A031 ADVANCED MATERIALS FOR GREEN VEHICLES

3 0 0 3

INTRODUCTION : Composite materials- Foam cored steel composite box beams -Plastic mouldings for open canopy shells- Reaction injection molding –Resin transfer molding – sheet Molding compounds- Ultra light weight construction case study (9)

GREEN COMPOSITE MATERIALS FROM LIQUEFIED BIOMASS : Introduction|- Liquefaction technique|- Foams|- Polyurethane foams (PUFs) from liquefied lignocellulosics Phenolic foam from liquefied lignocellulosics|- 1Molding materials- Liquefied wood as replacement in novolac-type resin- based composites|- Epoxy-type resins from liquefied biomass (9)

GREEN FIBERS : Introduction- Kenauf- Hemp- and Flax fibers- advantages and limitation- mechanical properties and comparison with Glass fiber- limitation- Binders used- Thermal resistance and chemical resistance (9)

BIODEGRADABLE POLYMER MATRIX : Poly-lactic acid (PLA) – synthesis- mechanical properties - thermal and creep properties- compression and injection molding - Factors Influencing Processing of Green Composite - Performance of Green Composite (9)

DESIGN OF GREEN BIO-COMPOSITES : Basics of green composite design- Failure Prediction in a Unidirectional Lamina- Maximum Stress Theory- Maximum Strain Theory- Tasi-Wu Failure Theory- Failure Prediction in Random Fiber Laminates- Tensile Testing of Bio-Composites- Impact Test of Bio-Composites (9)

Total L: 45

TEXT BOOKS:

1. Srikanth Pilla, Charles Lu , "Biocomposites in Automotive Applications", 2nd Edition, SAE International,, 2015.
2. Amar K. Mohanty, Manjusri Misra , "Natural Fibers, Biopolymers, and Biocomposites", 2nd Edition, CRC Taylor and Francis, 2009.

REFERENCES:

1. Georgios Koronis, Arlindo Silva , "Green Composites for Automotive Applications", 1st Edition, Woodhead Publisher, 2017.
2. Caroline Baillie , "Green Composites: Polymer Composites and the Environment", 1st Edition, Woodhead Publishing Limited, 2005.

19A032 FLEXIBLE MANUFACTURING SYSTEM

3 0 0 3

PRODUCTION SYSTEMS : Types of production - Job Shop, Batch and Mass production - Functions in manufacturing - Plant layouts: Process, product - fixed position - cellular layouts - Automated production systems; Automation principles and strategies - automated assembly lines (9)

FMS IMPLEMENTATION : Characteristics, types, equipments and its functions - Types of flexibility and performance measures - Planning phases, integration, system configuration - FMS layouts, simulation, FMS project development steps - Project management: Equipment development - host system development - functions of FMS host computer - FMS host - area controller function distribution - hardware and software development (9)

GROUP TECHNOLOGY AND PROCESS PLANNING : Group technology: Formation of part families-part classification - coding system, OPITZ and multi class coding systems - Production flow analysis-machine cell design - clustering methods, modern algorithms - benefits of GT - system planning - Process planning- approaches to automated process planning - study of a typical process plan - Manufacturing planning and control (9)

AUTOMATED MATERIAL HANDLING AND STORAGE : Automated material handling: Functions, types - analysis of material handling equipment - Design of conveyor and AGV systems - AS/RS; Storage: System performance, carousel storage system - WIP storage system - Interfacing material handling and storage with manufacturing (9)

MODELING AND ANALYSIS OF FMS : Simulation and petrinet modeling techniques - Lean and agile manufacturing concepts - JIT - Kanban - Poke Yoke (9)

Total L: 45

TEXT BOOKS:

1. H. K. Shivanand, M M Benal, V. Koti , ""Flexible Manufacturing System"", 1st Edition, New Age International Private Limited, Bengaluru, 2009.
2. 2Mikell P. Groover , ""Automation Production Systems &Computer Integrated manufacturing"", 4th Edition, Prentice Hall of India, New Delhi, 2016.

REFERENCES:

1. David J. Parrish , ""Flexible Manufacturing"", Butterworth-Heinemann, USA, 1993.
2. Radhakrishnan P, Subramanyan S, Raju V , ""CAD/CAM/CIM"", 4th Edition, New Age International Pvt. Ltd, 2018.
3. Joshi S B, Smith J S. , ""Computer Control of Flexible Manufacturing Systems"", Springer, 2012.

19A033 VEHICLE STABILITY AND CONTROL

3 0 0 3

LATERAL VEHICLE DYNAMICS AND CONTROL : Introduction -Kinematic Models - Dynamic Bicycle Model – From Body Fixed to Global Coordinates- State Feedback - Steady State Analysis- Steady State Cornering (9)

LONGITUDINAL VEHICLE DYNAMICS AND CONTROL : Introduction -Longitudinal Vehicle Model - Driveline Dynamics- Cruise control - Control System Architecture - Adaptive Cruise Control 4) Individual Vehicle Stability and String Stability - Automated Highway Systems - Longitudinal Control for Vehicle Platoons - String Stability with Inter- Vehicle Communication - Overview of Tire Models (9)

ELECTRONIC STABILITY CONTROL : Introduction -Vehicle Model - Control Design for Differential Braking Based Systems - Control Design for Steer-by-Wire Systems - Independent All Wheel Drive Torque Control (9)

AUTOMOTIVE SUSPENSION CONTROL : Introduction- LQR Formulation for Active Suspension Design- Performance of the Sky-Hook Damping Controller -Control with Hydraulic Actuators Optimal Semi-Active Suspensions- Interpretation of the Optimal Semi-Active Control Law - Calculation of Transfer Function Plots with Semi-Active Control Law (9)

ROLLOVER PREVENTION CONTROL : Introduction- Rollover Dynamics - Rollover Index and Active Rollover Prevention - Comparison of Performance with Various Rollover Indices- Roll prevention by braking and engine control – Roll control using damper (9)

Total L: 45

TEXT BOOKS:

1. Dean Karnopp , "Vehicle Stability", 2nd Edition, Marcel and Decker, NEw York, 2009.
2. A. Galip Ulsoy, Huei Peng, Melih Çakmakci , "Automotive Control Systems", 1st Edition, Cambridge University Press, 2012.

REFERENCES:

1. Wuwei Chen, Hansong Xiao, Qidong Wang , "Integrated Vehicle Dynamics and Control", 1st Edition, Wiley Publisher, 2009.
2. Wong J Y , "Theory of Ground Vehicles ,", 4th Edition, John Wiley and Sons, 2012.

19A034 ALTERNATIVE SOURCES OF ENERGY**3 0 0 3**

ENERGY DEMAND & SUPPLY : Energy supply-fossil fuel- nuclear fuel- renewable –energy prices- OPEC-politics- energy reserves- resources- the finite life of a resource. (9)

ENERGY STORAGE : Need to Store Energy- Electromechanical Storage - Thermal Storage - Chemical Storage: Batteries- Hydrogen Storage: The Hydrogen Economy- Fuel Cells- High-Temperature Fuel Cells – Thermodynamic Losses and Fuel Cell Efficiency. (9)

ECONOMICS OF ENERGY PROJECTS : Fundamental Concepts and Definitions- The Decision Making Process- The Time-Value of Money - Simple and Compound Interest- Cash Flow - Equivalence and Present Value – Cash Flow Calculations- Investment Appraisal Methods- NPV and Governmental Incentives or Disincentives. (9)

PHOTOVOLTAIC POWER PLANTS : Generation of electricity- output characteristics- dark-current electric parameters of a photovoltaic panel- model of a PV panel consisting of n cells in parallel- electric power supply- economic analysis of solar energy. (9)

POWER PLANT FUEL CELLS : Practical issues related to fuel cell stacking- low- and high-temperature fuel cells- constructional features - proton exchange-membrane fuel cells-DMFC-Solid oxide- load curve peak shaving with fuel cells- Maximal Load curve flatness at constant output power- reformers - electrolyzer systems - and related precautions. (9)

Total L: 45**TEXT BOOKS:**

1. Michaelides E , "Alternate Energy Sources", Springer Heidelberg Dordrecht, London, 2012.
2. Faret F, Simoes , "Integration of Alternative Sources of Energy", John Wiley & Sons, 2010.

REFERENCES:

1. Neresian , "Energy for the 21st Century: A comprehensive guide to Conventional and Alternatives Sources", Springer, Berlin, 2012.
2. Mariano Martín , "Alternative Energy Sources and Technologies: Process Design and Operation", Springer international Publishing, 2016.

19A035 VEHICLE TESTING AND TROUBLE SHOOTING**3 0 0 3**

WIND TUNNEL TEST : Test requirements - ground boundary simulation-wind tunnel selection and Reynolds number capability, model requirements, model details, model mounting - test procedure (9)

FUEL CONSUMPTION TEST : Type I & II, test route selection, vehicle test speeds, cargo weights, driver selection, test data form, calculations - Test on rough terrain, pot holes with laden and unladen conditions (9)

ENERGY CONSUMPTION TEST : Engine cooling fan, air conditioning and brake compressors, hydraulic pumps power consumption - Antilock brake systems energy consumption. (9)

VEHICLE SIMULATION AND TESTING : Fault insertion testing in system model - brake fluid leakage test in from single to all wheels - steering – vehicle in loop testing – braking test on split - conditions - Traction loss and roll instability simulation (9)

TROUBLE SHOOTING : Diagnosis of driveline systems - Diagnosis of chassis systems. (9)

Total L: 45**TEXT BOOKS:**

1. Crouse W.H.and Anglin D.L. , ""Automotive Mechanics""", Tata McGraw Hill Publishing Company,, New Delhi, 2004.
2. Rangan, Mani and Sharma , ""Instrumentation""", Tata McGraw Hill Publishing Company,, New Delhi, 2004.

REFERENCES:

1. SAE Hand book , "SAE Hand book, Vol. 3," SAE Publications,, 2000.
2. Hucho W H , ""Aerodynamic of Road vehicles "" , Butterworth Co. Ltd., 2011.
3. Tim Gilles , ""Automotive Service"" , Delmar Publishers, 1998..
4. Beckwith TG. and Buck N L, "Mechanical Measurements", Addition Wesley Publishing Company Limited,, 1995.

19A036 MODERN VEHICLE TECHNOLOGY**3 0 0 3**

TRENDS IN AUTOMOTIVE POWER PLANTS : Hybrid Vehicles – Stratified charged / lean burn engines – Hydrogen Engines- battery vehicles – Electric propulsion with cables – Magnetic track vehicles. (9)

SUSPENSION BRAKES AND SAFETY : Air suspension-Closed loop suspension-anti-skid braking system - Retarders - Regenerative braking safety cage -air bags-crash resistance (9)

PASSENGER COMFORT NOISE & POLLUTION : Reduction of noise – Internal & external pollution control through alternate fuels/ power plants-Catalytic converters and filters for particular emission. (9)

VEHICLE OPERATION AND CONTROL : Computer Control for pollution. noise control and for fuel economy- Transducers and operation of the vehicle like optimum speed and direction (9)

VEHICLE AUTOMATED TRACKS : Preparation and maintenance of proper road network-National highway network with automated roads and vehicles-Satellite control of vehicle operation for safe and fast travel. (9)

Total L: 45**TEXT BOOKS:**

1. Heinz Heisler , "Advanced Vehicle Technology", 2nd Edition, Butterworth and Heimenn, 2013.
2. James E. Duffy , "Modern Automotive Technology", 3rd Edition, Goodheart-Willcox Company, 2012.

REFERENCES:

1. Ljubo Vlacic, M. Parent, Fumio Harashima , "Intelligent Vehicle Technologies", 3rd Edition, Elsevier Publisher, 2014.
2. Julian Happian-Smith , "Introduction to Modern Vehicle Design", 3rd Edition, Butterworth and Heinemann Publisher, 2010.

19A037 ELECTRICAL CHARGING SYSTEM**3 0 0 3**

INTRODUCTION : Introduction to energy management issues - energy consumption in road network - distribution of charging facilities - interaction with the power grid (9)

TRAFFIC MODELLING FOR ELECTRIC VEHICLES : Basic notions of Markov Chains and Graph Theory - energy consumption - traffic load control - selfish routing for EVs - collaborative routing under feedback – balancing charging loads - protocol implementation (9)

CHARGING EVS : EV charging schemes - control architectures - communication requirements - degree of control actuation - measurement and forecasting requirements - operational time scales - operational time scales - charging policies - Wireless charging (9)

VEHICLE TO GRID CHARGING : V2G and G2V management of EVs - assumptions and constraints - management of active/reactive power exchange - V2G power flows - unintended consequences of V2G operations (9)

SHARING ELECTRIC CHARGE POINTS AND PARKING SPACES : Introduction - setting: parking spaces - dimensioning and statistics - dimensioning formulae efficient allocation of premium spaces - turning private charge points into public ones smart charging unit (9)

Total L: 45**TEXT BOOKS:**

1. Crissostomi E, Shorten R, Studli S and Wirth F , "Electric and Plug-in Hybrid Vehicle Networks –Optimization and Control", First, Taylor & Francis Group, New York, 2018.
2. Emadi. A , "Advanced Electric Drive Vehicles", First, Taylor&Francis, New York, 2015.

REFERENCES:

1. Hayes.G and Goodarzi , "Electric Powertrain- Energy Systems, Power Electronics and Drives", First, Jhon Wiley, Sussex, 2018.
2. Liu Wei , "Introduction to Hybrid vehicle systems Modelling and Control", 1st Edition, John Wiley, 2016.
3. Mi Chris and Masur Abul , "Hybrid electric vehicles", 1st Edition, John Wiley, 2018.

19A038 AUTOMOTIVE HVAC

3 0 0 3

REFRIGERATION : Methods of refrigeration - Air Refrigeration System and its applications - Vapour compression refrigeration system - Vapour absorption refrigeration system - Applications of refrigeration & air conditioning - Automobile air conditioning - Air conditioning for passengers, isolated vehicles, transport vehicles - Applications related with very low temperatures Classification, properties and selection criteria - Commonly used refrigerants - Alternative refrigerants - Eco-friendly refrigerants - Applications of refrigerants - Refrigerants used in automobile air conditioning (12)

PSYCHOMETRY : Psychometric properties, tables, charts - Psychometric processes - Comfort charts - Factor affecting comfort - Effective temperature - Ventilation requirements (6)

AIR CONDITIONING SYSTEMS AND LOAD ANALYSIS : Classification and layouts - Central / unitary air conditioning systems - Components like compressors, evaporators, condensers, expansion devices, fan blowers, heating systems etc. Load Analysis: Outside & inside design consideration - Factors forming the load on refrigeration & air conditioning systems - Cooling & heating load calculations - Load calculations for automobiles - Effect of air conditioning load on engine performance (9)

AIR DISTRIBUTION SYSTEMS : Distribution duct system, sizing, supply / return ducts - Types of grills, diffusers, ventilation, air noise level - Layout of duct systems for automobiles and their impact on load calculations. Air Routine & Temperature Control: Objectives - evaporator care air flow - Through the dash re - circulating unit - Automatic temperature control - Controlling flow - Control of air handling systems. (9)

AIR CONDITIONING SERVICE AND CONTROL : Air conditioner maintenance & service - servicing heater system - Removing & replacing components - Trouble shooting of air conditioning system - Compressor service, methods of dehydration, charging & testing. Air Conditioning Control: Common control such as thermostats - Humidistat us - Control dampers - Pressure cutouts and relays (9)

Total L: 45

TEXT BOOKS:

1. Mark Schnubel , "Automotive Heating and Air Conditioning", 5th Edition, Today's Technician, 2013.
2. Steven Daly , "Automotive Air Conditioning and Climate Control Systems", 1st Edition, Butterworth Heinemann, 2006.

REFERENCES:

1. Norman C. Harris , "Modern Air-Conditioning Practice", McGraw-Hill Education, 1984.
2. R.J. Dossat , "Principles of Refrigeration", 5th Edition, Prentice Hall, 2001.
3. Paul Lung , "Automotive Air Conditioning", C.B.S. Publisher & Distributor, New Delhi, 1991.
4. Stoecker WF, Jones JW , "Refrigeration and Air-Conditioning", Tata McGraw Hill, New Delhi, 1982.

19A039 MODELLING AND SIMULATION OF INTERNAL COMBUSTION ENGINES

3 0 0 3

MODELLING OF IC ENGINES : Heat of reaction - Hrp and Urp calculations, adiabatic, constant volume combustion, constant pressure combustion, temperature drop due to fuel vaporization, adiabatic flame temperature, mean effective pressure, torque and thermal efficiency at full throttle, part throttle and supercharged conditions. Spray models, flow models and combustion models. (9)

COMBUSTION IN SI ENGINES : Combustion in premixed flames - Stages of combustion, flame propagation, rate of pressure rise, cycle to cycle variation, abnormal combustion - Theories and effect of engine operating variables on combustion. (9)

COMBUSTION IN CI ENGINES : Combustion in diffusion flames - Droplet and spray combustion theory, stages of combustion, delay period, peak pressure, heat release, gas temperature and diesel knock. (9)

SIMULATION OF IC ENGINES : SI and CI engine simulation - Air standard cycle, fuel air cycle, progressive combustion cycle and actual cycle simulation - Part throttle, full throttle and supercharged conditions. (9)

SIMULATION OF NEW ENGINE CONCEPTS : Dual fuel engine, low heat rejection engine, lean burn engine, variable compression ratio engine, homogeneously charged compression ignition engine and controlled auto ignition engine. (9)

Total L: 45

TEXT BOOKS:

1. Ganesan V , "Computer Simulation of Spark-Ignition Engine Processes", Universities Press (I) Ltd, Hyderabad, 2009.
2. Ganesan V , "Computer Simulation of Compression-Ignition Engine Processes", University Press (I) Ltd, Hyderabad, 2010.

REFERENCES:

1. Ganesan V , "Internal Combustion Engines", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
2. Heywood J.B , "Internal Combustion Engine Fundamentals", McGraw Hill Book Co, USA, 1988.
3. Ramoss A L , "Modeling of Internal Combustion Engines Processes", McGraw Hill Publishing Co, 1992.
4. Ashley Campbel , "Thermodynamic analysis of combustion engines", John Wiley & Sons, New York, 1986.

19A040 ADVANCED THEORY OF INTERNAL COMBUSTION ENGINES

3 0 0 3

COMBUSTION PROCESSES : Combustion in premixed and diffusion flames, combustion process in IC engines, adiabatic flame temperature, effect of super charging and scavenging on combustion. - Combustion in premixed and diffusion flames - combustion process in IC engines - adiabatic flame temperature - effect of super charging and scavenging on combustion. (9)

ABNORMAL COMBUSTION IN SI ENGINES : Stages of combustion - flame propagation - rate of pressure rise - cycle-to-cycle variation - abnormal combustion - theories of detonation - heat release. (9)

COMBUSTION AND KNOCK IN CI ENGINES : Droplet and spray combustion theory - stages of combustion – delay period - peak pressure - heat release - gas temperature - diesel knock. (9)

COMBUSTION OF FUELS : Combustion stoichiometry of petrol - diesel - alcohol and hydrogen fuels - chemical energy and heating values - chemical equilibrium and maximum temperature - flame velocity and area of flame front - fuel spray characteristics - penetration and atomization. (9)

ADVANCED IC ENGINES : Adiabatic and low heat rejection engines - homogeneously charged compression ignition engines & multi - fuel engines - stratified charged and lean burn engines. (9)

Total L: 45

TEXT BOOKS:

1. Heywood J B , "Internal Combustion Engine Fundamentals", McGraw Hill Book Co, USA, 2010.
2. Ganesan V , "Internal Combustion Engines", Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2008.

REFERENCES:

1. Lewis B, Pease R N, Taylor H S , "Combustion Process High Speed Gas dynamics and Jet Propulsion Series", Princeton University Press, New Jersey, 1999.
2. Taylor E F , "The Internal Combustion Engines", International Book Co, Pennsylvania, 2002.
3. Spalding D B , "Some Fundamental of Combustion", Butterworth Science Publications, London, 2004.
4. Ganesan V , "Computer Simulation of Spark Ignition Engine Processes", Universities Press (India) Ltd, Hyderabad, 1996.

19A041 COMPUTATIONAL FLUID DYNAMICS

3 0 0 3

INTRODUCTION : Application areas of CFD - Basic concepts of fluid flow - governing equations - conservation of mass - momentum and energy – Navier-stokes and energy equation for Newtonian fluid – Mathematical classification of flow - hyperbolic - parabolic - elliptic and mixed flow types. (9)

FINITE DIFFERENCE METHODS : Forward - backward and central difference schemes - Explicit and implicit methods: Numerical solution for heat transfer and fluid flow problems for steady state and transient conditions - Stability analysis and error estimation (12)

GRID GENERATION : Choice of grid - grid oriented velocity components - cartesian velocity components - staggered and collocated arrangements (6)

CFD TECHNIQUES : Lax - Wendroff technique - McCormack's technique - Relaxation technique. ADI technique - Pressure correction technique - SIMPLE algorithm. Fluid flow and convection problems: Upwind scheme - Stability criteria. (9)

TURBULENCE MODELING AND CASE STUDIES : Turbulence energy equation- one-equation model - the k- ω model - the k- ϵ model. Modeling and analysis of heat transfer - fluid flow and automobile components using CFD packages. (9)

Total L: 45

TEXT BOOKS:

1. John D Anderson , "Computational Fluid Dynamics – The Basics with Applications", McGraw Hill, New York, 2008.
2. Muralidhar K, Sundararajan T , "Computational Fluid Flow and Heat Transfer", Narosa Publications, NewDelhi, 2009.

REFERENCES:

1. Chung T J , "Computational Fluid Dynamics", Cambridge University Press, London, 2002.
2. David C Wilcox , "Turbulence Modeling for CFD", DCW Industries, 1993.
3. Versteeg H K, Malalasekara W , "An Introduction to Computational Fluid Dynamics - The Finite Volume Method", Longman, 1995.

19A042 VALUE ENGINEERING

3 0 0 3

INTRODUCTION : Value engineering concepts - advantages - applications - problem recognition - and role in productivity - criteria for comparison - element of choice. ORGANIZATION: Level of value engineering in the organization - size and skill of VE staff - small plant - VE activity - unique and quantitative evaluation of ideas (9)

VALUE ENGINEERING JOB PLAN : Introduction - orientation - information phase - speculation phase - analysis phase. Selection and Evaluation of value engineering Projects - Project selection - methods selection - value standards - application of value engineering methodology. ANALYSIS FUNCTION: Anatomy of the function - use esteem and exchange values - basic vs. secondary vs. unnecessary functions. Approach of function - Evaluation of function - determining function - classifying function - evaluation of costs - evaluation of worth - determining worth - evaluation of value (9)

VALUE ENGINEERING TECHNIQUES : Selecting products and operation for value engineering action - value engineering programmes - determining and evaluating function(s) assigning rupee equivalents - developing alternate means to required functions - decision making for optimum alternative - use of decision matrix - queuing theory and Monte Carlo method make or buy - measuring profits - reporting results - follow up - Use of advanced technique like Function Analysis System. (9)

VERSATILITY OF VALUE ENGINEERING : Value engineering operation in maintenance and repair activities - value engineering in non-hardware projects. Initiating a value engineering programme Introduction - training plan - career development for value engineering specialties. Fast diagramming: cost models - life cycle costs (9)

VALUE ENGINEERING LEVEL OF EFFORT : Value engineering team - co-coordinator - designer - different services - definitions - construction management contracts - value engineering case studies. (9)

Total L: 45

TEXT BOOKS:

1. Anil Kumar Mukhopadhyaya , ""Value Engineering: Concepts Techniques and applications"", 1st Edition, SAGE Publications, New Delhi, 2010.
2. Del L. Younker , ""Value Engineering analysis and methodology"", Marcel Dekker Inc, New York, 2011.

REFERENCES:

1. Lawrence D. Miles , ""Techniques of Value Analysis and Engineering"", 3rd Edition, Eleanor Miles Walker, United States of America, 1989.
2. Abate O. Kassa , ""Value Analysis and Engineering Reengineered: The Blueprint for Achieving Operational Excellence and Developing Problem Solvers and Innovators"", 1st Edition, CRC Press, Taylor & Francis Group, USA, 2016.

19A043 COMMERCIAL FLEET OPERATION

3 0 0 3

INTRODUCTION AND TRANSIT OPERATION : Modes of transport, road transport - Types of roads, advantages, motor transport in India - Route planning - Route location, stop location, route schedules, vehicle and labor scheduling. Traffic control - Traffic signals, signal timing. (9)

FORMS OF OWNERSHIP : Sole proprietorship - partnership - private limited company - public limited company - statutory company - local authority undertaking / municipal transport company - joint venture. (8)

COSTS & FARES : Operating costs and types of vehicles - types of fare structure - types of fare collecting methods - Requirement of buses and frequency - construction of bus station. (8)

GARAGE MANAGEMENT AND VEHICLE MAINTENANCE : Garage administration - types of garages - one spanner - two spanner - three spanner - break down truck symbol - government approved workshops - Tools- Objectives of maintenance - breakdown maintenance - preventive maintenance - tyre maintenance tips and failures. Fuel saving techniques - fitness certificate. (9)

LEGAL ASPECTS : Motor vehicle act - Registration - necessity of permits - insurance - test of competence to drive - mistake / offences for which a driver can be punished - adult workers - Hours of work - running time - split duty - journey time - round journey time - layover - frequency. (10)

Total L: 45

TEXT BOOKS:

1. John E Dolce , "Fleet management", McGraw-Hill Co, 2004
2. Asvin Goel , "Fleet Telematics: Real-time management and planning of commercial vehicle", 8th Edition, Springer, 2008.

REFERENCES:

1. Kitchin L D , "Bus operation", Illiffe and Sons Ltd, London, 1992.
2. Tim Giles , "Automotive Service - Inspection, Maintenance, and Repair", Alar Elken Publications, 2007.
3. Khanna O P , "Industrial Engineering and Management", Dhanpat Rai Publications, 2010.

19A044 QUALITY ASSURANCE AND RELIABILITY

3 0 0 3

THE MEANING OF QUALITY AND QUALITY IMPROVEMENT DIMENSIONS OF QUALITY : history of quality methodology - quality control - Quality of design and quality of conformance - Quality policy and objectives - Economics of quality. Modeling process quality: Describing variation - frequency distribution - continuous and discrete - probability distributions - pattern of variation (9)

STATISTICAL QUALITY CONTROL: CONCEPT OF SQC : Chance and assignable causes of variation - statistical basis of control chart - basic principles - choice of control limits - sample size and sampling frequency - analysis of patterns on control charts. The magnificent seven. Control chart for variables: X-bar and R charts - X-bar and S charts - control chart for individual measurement. Application of variable control charts. - Statistical Quality Control: Concept of SQC - Chance and assignable causes of variation - statistical basis of control chart - basic principles - choice of control limits - sample size and sampling frequency - analysis of patterns on control charts. (9)

CONTROL CHART FOR ATTRIBUTES: CONTROL CHART FOR FRACTION NON CONFORMING : P-chart - NP-chart - C-chart and U-chart. Demerit systems - choice between attribute and variable control chart. SPC for short production runs. Process capability analysis using histogram and probability plot - capability ratios and concept of six sigma. - Control chart for attributes: control chart for fraction non conforming P-chart - NP-chart - C-chart and U- chart. Demerit systems - choice between attribute and variable control chart - SPC for short production runs - Process capability analysis using histogram and probability plot - capability ratios and concept of six sigma. (9)

QUALITY ASSURANCE : Concept - advantages - field complaints - quality rating - quality audit. Acceptance Sampling: Fundamental concepts in acceptance sampling - operating characteristics curve. Acceptance sampling plans - single - double and multiple sampling plans - LTPD - AOQL - AOQ. Introduction to Quality systems like ISO 9000 and ISO 14000. (9)

RELIABILITY AND LIFE TESTING- FAILURE MODELS OF COMPONENTS : definition of reliability - MTBF - Failure rate - common failure rate curve - types of failure - reliability evaluation in simple cases of exponential failures in series - paralleled

and series-parallel device configurations - Redundancy and improvement factors evaluations - Introduction to Availability and Maintainability - Introduction to Taguchi Method of Design of Experiments – Quality loss function. (9)

Total L: 45

TEXT BOOKS:

1. Charles E. Ebeling , "An Introduction to Reliability and Maintainability Engineering", 2nd Edition, Tata McGraw-Hill , 2010.
2. Douglas C Montgomery , "Introduction to Statistical Quality Control", 2nd Edition, Wiley, 2008.

REFERENCE:

1. E. L. Grant and Richard S. Leavenworth , "Statistical Quality Control", 2nd Edition, Tata McGraw-Hill, 2000.

19A045 TOTAL QUALITY MANAGEMENT

3 0 0 3

INTRODUCTION : Definitions of the terms - quality, quality planning, quality control, quality assurance, quality management, Total Quality Management (TQM) as per ISO 8402 - overview on TQM - The TQM axioms - Commitment - Scientific knowledge - Involvement - Consequences of total quality. ISO 9000 Series Quality System Standards: The structure of ISO 9000 series quality system standards - certification process - action plan development for cases. Study of quality audit (10)

THE DEMING AND JURAN APPROACH TO TQM : Deming's fourteen points on quality management - five DDs - implementing the Deming philosophy - action plan - the Deming cycle - questions and opinions of Deming. : Developing a habit of quality - Juran quality trilogy - the universal break through sequence - comparison Juran and Deming approaches. (10)

CROSBY AND THE QUALITY TREATMENT AND KAIZEN: : Crosby's diagnosis of a troubled company - Crosby's quality vaccine - Crosby's absolutes for quality management - Crosby's fourteen steps for quality improvement. Kaizen and innovation - the Kaizen management practices - total quality control (TQC) - approaches of Faigenbaum, Ishikawa - Kaizen and TQC - Kanban systems - small group activities - quality control circles - suggestion systems - comparison of Kaizen and Deming's approach (10)

SUPPORTING TOOLS, ACTIVITIES AND TECHNIQUES IN TQM PROJECTS: : Affinity diagram - bar chart - block diagram - brainstorming - cause and effect analysis - customer - supplier relationship checklist - decision analysis - flow charts - force field analysis - line graph/run charts - Pareto analysis - quality costing - Quality Function Deployment (QFD) - quality project approach and the problem solving process. Quality in auto service station. (8)

STRATEGIC QUALITY MANAGEMENT : Integrating quality into strategic management - Quality and the management cycle - Resources for Quality activities - Training for Quality - Self Managing Teams - Role of the Quality Director - Obstacles to achieving successful Strategic Quality Management. Five S study (7)

Total L: 45

TEXT BOOKS:

1. Dale H.Besterfield, Carol Besterfield, Geln and Mary , "Total Quality Management", Pearson Education, New Delhi, 2008.
2. Juran J.M, and Gryna F.M , "Quality Planning and Analysis - From Product Development through Use", Tata McGraw Hill, New Delhi, 2011.

REFERENCES:

1. Subburaj Ramasamy , "Total Quality Management", Tata McGraw Hill, New Delhi, 2010.
2. Logothetics. N , "Managing for Total Quality - From Deming to Taguchi and SPC", Prentice Hall, New Delhi, 2003.

19A046 MATERIALS FOR AUTOMOBILE INDUSTRY

3 0 0 3

INTRODUCTION : Classification and characteristics of metals, ceramics, polymers and composites. (5)

IRON AND STEELS : Cast iron - Austempered ductile iron, compacted graphite iron, steels - Plain carbon steels, low alloy steels, HSLA steels, IF steels, bake hardening steels, TRIP steels, ultra high strength steels, stainless steels - production, properties and applications. (12)

NON-FERROUS ALLOYS : Aluminum alloys - Cast alloys, wrought alloys, age hardenable alloys, working and heat treatment, applications in automobiles, Magnesium alloys - Cast and wrought alloys, working and heat treatment, applications. Titanium alloys. (12)

POLYMERS AND CERAMICS : Processing of polymers, brief description of equipment and process details of extrusion, injection molding, thermoforming, blow molding, concept of polymer design, and selection criteria - Preparation and forming of ceramics, applications. (11)

COMPOSITE MATERIALS : Production of composite materials and products, moulding and forming of composites, machining and joining of composites, application of composites in automobiles, metal matrix composites, polymer matrix composites and ceramic matrix composites, applications. (5)

Total L: 45

TEXT BOOKS:

1. Balram Gupta , "Aerospace Materials Vol. 1,2,3,4 and 5", S. Chand Publishing, New Delhi, 2002.
2. George E. Dieter , "Mechanical Metallurgy", 3rd Edition, McGraw Hill Education, 2017.

REFERENCES:

1. ASM Handbook , "American Society for Metals Volume 1, 2, 4, 20 and 21", ASM International, 2018.
2. John Brown , "Foseco Ferrous and Non Ferrous Foundryman's Handbook", Butterworth- Heinemann, 1999.
3. Charles A Harper , "Handbook of Plastics, Elastomers and Composites", 3rd Edition, McGraw Hill, 1997.
4. Kurt Lange , "Handbook of Metal Forming", 2nd Edition, Society of Manufacturing Engineers, 2004

19A047 PROCESS PLANNING AND COST ESTIMATION

3 0 0 3

PROCESS PLANNING : Production drawing - Process plan - information required - production equipment and tooling selection - selection of process parameters - Process sheet - contents and preparation of process sheet - Group technology and automated process planning - part family, methods of forming part families - classification and coding systems - rank order clustering technique, composite part, cellular manufacturing - Automated process planning - variant and generative approaches (9)

ESTIMATION AND COSTING : Differences between estimation and costing - qualifications of an estimator - Estimation - types. Classification of costs - Cost grid, preparation of cost sheet - Labor cost - estimation of labour cost - Introduction to time study and labour norms - Job evaluation. incentive schemes and wage administration, learning curve (9)

MATERIAL, OVERHEAD COSTS : Material cost estimation - make or buy decision analysis - Overhead cost - elements in overhead cost - factory, administrative, sales and distribution expenses - Methods of absorbing overheads - direct labour, direct material, direct labour hour - machine hour rate methods - Activity based costing. Depreciation - purpose, various methods of depreciation. (9)

COST ESTIMATION : Estimating the cost of machined components - optimum machining conditions - Taylor's equation, optimum cutting speed for minimum cost - model for maximum production - Cost estimation of welded components, forgings and castings (9)

COST MANAGEMENT : Cost control, variance analysis - labor, material cost variances - Value engineering (VE) - steps, VE job plan, different phases, function analysis system technique (FAST) - Target costing. Benefit/cost analysis - Break even analysis - linear, non-linear models - different areas of applications, multi product break even analysis - Time value of money. (9)

Total L: 45

TEXT BOOKS:

1. Peter Scallan , ""Process Planning"", Butterworth Heinemann, 2004.
2. Sinha B P , ""Mechanical Estimating and Costing"", Tata McGraw Hill Education, 2015.

REFERENCES:

1. Groover M P , ""Automation, Production Systems and Computer-Integrated Manufacturing"", Pearson Education, 2015.
2. Lal Nigam B M, Jain I C , ""Cost Accounting"", Prentice Hall of India, 2007.
3. Richard J Park , ""Value Engineering – A Plan for Inventions"", CRC Press, 1998.
4. Chang T C, Wysk R A , ""An Introduction to Automated Process Planning Systems"", Prentice Hall Inc, 1984.

19A048 LEAN METHODS FOR AUTOMOBILE ENGINEERS

3 0 0 3

INTRODUCTION : SEVEN forms of waste and their description; Historical evolution of lean manufacturing; Global competition - Customer requirements - Requirements of other stake holders - Meaning of Lean Manufacturing System (LMS) - Meaning of Value and waste - Need for LMS - Symptoms of underperforming organizations - Meeting the customer requirement - Elements of LMS. (9)

PRIMARY TOOLS USED IN LMS : Meaning and Purpose of 5S Work place organization - 5S process – Sort - Set in order - Shine - Standardize - Sustain - Implementing 5S - Meaning and purpose of TPM - Pillars of TPM - Conditions for TPM success - TPM implementation process - Overall Equipment Effectiveness and problems on computation of OEE. (9)

PRIMARY TOOLS USED IN LMS CONTD : Process Mapping and Value Stream Mapping (VSM) – Need for process maps - advantages - types and its construction - steps in preparing VSM; Concept of work Cell and its design - Line balancing algorithms and problems. (9)

SECONDARY TOOLS USED IN LMS : Cause and effect diagram - Pareto chart - Radar chart - Poke Yoke - Kanban - Automation - SMED - Standardized fixture - DFMA - JIT - Visual workplace - problems on Pareto analysis and computation of number of Kanban. (9)

LMS RULES : Stability - Management - Standardized work - Pull system - Continuous improvement. Lean Implementation: Training - selecting the projects - preparing project charter - project implementation - Project review. Implementing LMS for higher productivity: Operator - process - machinery and equipment – workplace organization - Inventory - LMS Design Process. (9)

Total L: 45

TEXT BOOKS:

1. Gopalakrishnan N , ""Simplified Lean Manufacture: Elements, Rules, Tools and Implementation"", PHI Learning Pvt Limited, New Delhi, 2010.
2. Pascal Dennis , ""Lean Production Simplified"", 2nd Edition, Productivity Press, New York, 2007.

REFERENCE:

1. Jeffrey Liker , ""The Toyota Way"", 19th Edition, Tata McGraw-Hill, New Delhi, 2004.

19A049 QUALITY MANAGEMENT SYSTEM FOR AUTOMOTIVE INDUSTRY

3 0 0 3

BASIC CONCEPTS OF QUALITY : quality, classification of quality systems and services - product quality design - quality engineering in design of production processes - quality in reliability and safety - quality engineering in production - quality engineering in service (9)

QUALITY MANAGEMENT SYSTEMS : quality management – a conceptual frame work - dimensions of quality - costs of quality - quality system standards - ISO 9000 clauses and its interpretations - ISO TS16949 clauses and interpretation (9)

MODERN MANAGEMENT TOOLS AND TECHNIQUES : Introduction to Modern Management Techniques - 5s concepts - Kaizen techniques - Six sigma methodologies - Quality circles - Taguchi loss function - POKE –YOKE Techniques (9)

ISO TS16949 REQUIREMENTS : Advanced Product Quality Planning (APQP) - Design Failure Mode Effects Analysis Process Failure Mode Effects Analysis - Production Part Approval Process (PPAP) (9)

QUALITY TOOLS AND MEASUREMENT SYSTEMS ANALYSIS : Concepts of SPC detection vs. prevention - Data collection methods - Statistical Tools - Understanding of measurement systems - Variable Gauge R&R - Introduction to Hypothesis Testing - ANOVA - Correlation Analysis - Single and Multiple Regression (9)

Total L: 45

TEXT BOOKS:

1. David Hoyle , "Automotive quality system Handbook", 2nd Edition, Butterworth – Heinemann Ltd, Oxford, 2000.
2. William M Feld , "Lean Manufacturing: Tools, Techniques and How to Use Them", APICS, 2001.

REFERENCES:

1. Montgomery Douglas C , "Introduction to Statistical Quality Control", John Wiley and Sons, New Delhi, 2007.
2. Logo Thetis N , "Managing for Total Quality – From Deming to Taguchi and SPC", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
3. Aiag , "Advanced product quality planning and control plan", 2nd Edition, Standards media, 2008.

19A050ELECTRIC VEHICLE THERMAL ENGINEERING**3 0 0 3**

Introduction: Introduction on Electric Powertrain Systems - Introduction to thermal management systems in EV - Source of heat generation in electric power train- Types of cooling architecture in EVs- Introduction to Thermodynamics and Heat transfer- Modes to heat transfer (9)

Thermal Management of electric Motor and HV Battery: Motor types and applications- Motor performance characteristics- Electric Motor thermal system – Modeling and simulation- HV battery classifications- Factors effecting battery performance- Types battery cooling methods- Control system design for BMS-Motor specifications for EVs (9)

Thermal Management of Power electronics and 3D Thermal simulation: Introduction- Power Loss Modelling- Parameter Identification- Sensitivity Analysis- Heat transfer Mechanism- Thermal influence & component protection, evaluation on Battery management system- Heat network across vehicle sub system[motor]- Concept design & different type of cooling channel design. (9)

HVAC Cooling: Introduction- Components of HVAC system- Power consumption from HVAC system-Impact of HVAC operation on EV performance- Modeling& Simulation of HVAC system (9)

Controller design for Thermal system: State space control & Design of Observer- Introduction to Vehicle Control unit & Thermal controls- Performance Optimization by Thermal control- Parameter Identification- Sensitivity analysis (9)

Total: 45 Hours**Text Book:**

1. Ibrahim Dincer, Halim S Hamut and Nader Javani "Thermal Management of Electric Vehicle Battery Systems " John Wiley 2017
2. Bruno Sacrasati and Werner Tillmatz "Advances in Battery Technology for Electric Vehicles " Elsevier Woodhead Publishing Series in Energy 2015

References:

1. Ali Emadi, "Advanced Electric Drive Vehicles" CRC Press, 2014.
2. Micah Toll, "The Ultimate Do It Yourself Ebike Guide: Learn How To Build Your Own Electric Bicycle" ISBN 978-09899067-9 1, 2013.

LANGUAGE ELECTIVES**19G001 COMMUNICATION SKILLS FOR ENGINEERS****0 0 4 2****COMMUNICATION CONCEPTS:**

Process of Communication
Inter and Intrapersonal Communication
Inter and Intrapersonal Communication Activities (9)

FOCUS ON SOFT SKILLS:

Etiquette — Work Place etiquette — Telephone etiquette
Body Language
Persuasive Communication
Public Speaking
Critical Reasoning and Conflict Management based on Case Studies
Group Communication
Meetings
Interview Techniques (14)

TECHNICAL WRITING:

Technical Writing Principles
Style and Mechanics
Technical Definitions – Physical, Functional and Process Descriptions
Technical Report Writing
Preparing Instructions and Manuals

Interpretation of Technical Data (15)

BUSINESS CORRESPONDENCE:

Writing Emails
Preparing Resumes
Memos
Technical and Business Proposals (7)

TECHNICAL COMMUNICATION:

Seminars
Process Description and Group Discussions
Use of Visual Aids (15)

Total P: 60

TEXT BOOKS:

1. Faculty Incharge "Course Material on "Communication Skills for Engineers"", PSG College of Technology., Coimbatore, 2019

REFERENCES:

1. Jeff Butterfield "Soft Skills for Everyone", Cengage Learning., New Delhi, 2013
2. Jean Naterop B and Rod Revell "Telephoning in English", Cambridge University Press., Cambridge, 2011
3. David A Mc Murrey and Joanne Buckley "Handbook for Technical Writing", Cengage Learning., New Delhi, 2011
4. Simon Sweeney "English for Business Communication", Cambridge University Press., New Delhi, 2012

19G002 GERMAN- LEVEL A1.1

0 0 4 2

GUTEN TAG! :

1. To greet, learn numbers till 20, practice telephone numbers & e mail address, learn alphabet, speak about countries & languages
2. Vocabulary: related to the topic
3. Grammar: W — Questions, Verbs & Personal pronouns I. (10)

FREUNDE, KOLLEGEN UND ICH:

1. To speak about hobbies, jobs, learn numbers from 20; build dialogues and frame simple questions & answers
2. Vocabulary: related to the topic
3. Grammar: Articles, Verbs & Personal pronouns II, sein & haben verbs, ja/nein Frage, singular/plural (10)

IN DER STADT:

1. To know places, buildings, question, know transport systems, understand international words; build dialogues and write short sentences
2. Vocabulary: related to the topic
3. Grammar: Definite & indefinite articles, Negotiation, Imperative with Sien verbs (12)

GUTEN APPETIT! :

1. To speak about food, shop, converse; Vocabulary: related to the topic; build dialogues and write short sentences
2. Grammar: Sentence position, Accusative, Accusative with verbs, personal pronouns & prepositions, Past tense of haben & sein verbs (13)

TAG FÜR TAG/ZEIT MIT FREUNDEN:

1. To learn time related expressions, speak about family, about birthdays, understand & write invitations, converse in the restaurant; ask excuse, fix appointments onphone
2. Vocabulary: related to the topic
3. Grammar: Time related prepositions, Possessive articles, Modalverbs (15)

Total P: 60

TEXT BOOKS:

1. Dengler Stefanie "Netzwerk A1.1", Klett-Langenscheidt Gmbh., München, 2013
2. Sandra Evans, Angela Pude "Menschen A1", Hueber Verlag., Germany, 2012

REFERENCES:

1. Stefanie Dengler "Netzwerk A1", Klett-Langenscheidt Gmbh., München, 2013
2. Hermann Funk, Christina Kuhn "Studio d A1", Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2009
3. Rosa-Maria Dallapiazza "Tangram Aktuell 1 (Deutsch als Fremdsprache)", Max Hueber Verlag., Munchen, 2004
4. Christiane Lemcke und Lutz Rohrmann "Grammatik Intensivtrainer A 1", Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2012

19G003 FRENCH LANGUAGE LEVEL 1

0 0 4 2

PARTS OF SPEECH:

1. inviter et répondre à une invitation, Pronoms sujets
2. L'article définis, l'article indéfinis
3. Conjugation : présent, adjectifs possessifs
4. interrogation, décrire les personnes
5. La vie de quatre parisiens de professions différentes (12)

ELEMENTS OF GRAMMAR :

1. Exprimer l'ordre et l'obligation demander et commander
2. l'adjectif possessifs, l'article partitif, l'article démonstratif, négation ne
3. pas, l'article contracté
4. verbe pronominaux
5. prepositions (12)

SENTENCE STRUCTURE :

1. Raconter et reporter-donner son avis
2. Futur simple, pronom complètement d'objet direct, passé composé
3. plusieurs région de France, imparfait, pronom y/en, imparfait (12)

TENSES AND NUMBERS :

1. Demander l'autorisation-passé récent, futur proche
2. La vie administrative et régionale, Pluriel des noms, moyens de transport (12)

DISCOURSE :

1. le discours rapporté, décrire un lieu, exprimer ses préférences
2. décrire la carrière, discuter d'un système éducation de France
3. parler de la technologie de l'information (12)

Total P: 60

TEXT BOOKS:

1. Christine Andant étal "À propos (livre de l'élève", LANGER., NEW DELHI, 2012
2. Myrna Bell Rochester "Easy French Step By Step", MCGrawhill Companies., USA, 2008

REFERENCES:

1. Michael D. Oates "Entre Amis: An Interactive Approach", Houghton Mifflin., 2005 , 5th
2. Bette Hirsch, Chantal Thompson "Moments Literaries : An Anthology for intermediate French", , ,
3. Simone Renaud, Dominique van Hooff "En bonne forme", , ,

19G004 BASIC JAPANESE

0 0 4 2

JAPANESE PEOPLE AND CULTURE :

1. Basic greetings and responses
2. Basic script — Method of writing hiragana and katakana — Combination sounds and simple words
3. Self introductions: "Hajimemashite" -Demonstratives "Kore", "Sore", "Are"— Demonstrative "Kono", "Sono", "Ano"
4. Possessive noun particle "no" — Japanese apartments: Greeting your neighbor (12)

PARTICLE "NI (AT)" FOR TIME :

1. kara (from) ~ made(until) — Particle "to (and)"
2. Time periods: Days of the week, months, time of day -Verbs (Present / future and pasttense)
3. Telephone enquiry: Asking for a phone no. And business hours- Destination particle "e". (12)

LIKES AND DISLIKES :

1. Potential verbs (wakarimasu and dekimasu) — "Kara (~ because)"
2. Adverbs — Asking some one out over the phone-Verbs denoting presence
3. Introduction to Adjectives (na and ii type) -Verb groups — I, II and III — Exercises to group verbs- Please do (te kudasai)
4. Present continuous tenses (te imasu) — Shall I? (~ mashou ka) — Describing a natural phenomenon (It is raining) (12)

DIFFERENT USAGES OF ADJECTIVES :

1. Comparison — Likes and dislikes — Going to a trip- Need and desire (ga hoshii) — Wanting to . . . (Tabeti desu)- Going for a certain purpose (mi -ni ikimasu)
2. Choosing from a menu-Adjectives ("i" and "na" type) — Adjectives (Positive and negative useage) (12)

ROLE PLAYS IN JAPANESE :

1. Framing simple questions & answers

2. Writing Short paragraphs & Dialogues
3. A demonstration on usage of chopsticks and Japanese tea party (12)

Total P: 60

TEXT BOOKS:

1. Minna no Nihongo, Honsatsu Roma "ji ban (Main Textbook Romanized Version)", . International publisher — 3A Corporation., Tokyo,2012

REFERENCES:

1. Eri Banno et.al "Genki I: An Integrated Course in Elementary Japanese I -Workbook", ., 1999
2. Tae Kim "A Guide to Japanese Grammar: A Japanese Approach to Learning Japanese Grammar", ., 2014
3. Minna No Nihongo "Translation & Grammatical Notes In English Elementary",,,

ONE-CREDIT COURSES

19AF01 GASOLINE ENGINE MANAGEMENT SYSTEM

1 0 0 1

GASOLINE ENGINE MANAGEMENT SYSTEM : Three way catalytic converter- conversion efficiency versus lambda. Layout and working of SI engine management systems like Bosch L-Jetronic and LH-Jetronic. Group and sequential injection techniques. Working of the fuel system components. Cold start and warm up phases - idle speed control - acceleration and full load enrichment - deceleration fuel cut off. Fuel control maps - open loop control of fuel injection and closed loop lambda control. Electronic ignition systems and spark timing control. Closed loop control of knock. (15)

Total L: 15

REFERENCES:

1. Konrad Reif , "Gasoline Engine Management: Systems and Components", First Edition, Springer Vieweg Publisher, 2012.
2. Dave Walker , "Engine Management: Optimising Carburettors, Fuel Injection and Ignition Systems", First Edition, Haynes, Publishers, 2001.

19AF02 DIESEL ENGINE MANAGEMENT SYSTEM

1 0 0 1

DIESEL ENGINE MANAGEMENT SYSTEM : Fuel injection system parameters affecting combustion- noise and emissions in CI engines. Pilot - injection - advanced and post injection . Electronically controlled Unit Injection system. Layout of the common rail fuel injection system. Working of components like fuel injector - fuel pump - rail pressure limiter - flow limiter - EGR valves - Emission management system - Closed loop control of detonation - NOx management systems (15)

Total L: 15

REFERENCES:

1. Konrad Reif , "Diesel Engine Management: Systems and Components", 2nd Edition, Springer Vieweg Publisher, 2014.
2. Charles O. Probst , "Corvette Fuel Injection & Electronic Engine Management", 2nd Edition, Bentley Publishers, 2001.

19AF03 VEHICLE SYSTEM ENGINEERING

1 0 0 1

VEHICLE SYSTEM ENGINEERING : Introduction to systems engineering –System modelling and design concept- steering system modeling – forces and moments calculation- suspension system modeling- elastokinematics of suspension systems – Brake system modeling – brake force to deceleration calculation – Maximum achievable deceleration- Introduction to multidegree degree of freedom model – Tyre modeling (15)

Total L: 15

REFERENCES:

1. Markus Maurer, Hermann Winner , "Automotive Systems Engineering", 2nd Edition, Springer Publishers, 2013.
2. Hermann Winner, Günther Prokop, Markus Maurer , "Automotive Systems Engineering II", 2nd Edition, Springer Publisher, 2007.

19AF04 COMPUTER AIDED INDUSTRIAL DESIGN FOR AUTOMOBILES

1 0 0 1

INTRODUCTION : Computer aided industrial design tools - Alias design products - Alias design interface. (5)

AN OVERVIEW ON COMPUTER AIDED INDUSTRIAL DESIGN : Features of curve - Creating curves - Transform tools - Creating a surface - Projecting curves on surface - Mirroring objects - Stretching a curve - Breaking a curve at inflections - Rebuilding and planarizing a curve and Advanced surface creation - Data transfer from CAID to CAD. (10)

Total L: 15

REFERENCES:

1. Sham Tickoo , "Learning Autodesk Alias Design 2016", CADCIM Technologies, 2016.
2. Tony Lewin, Ryan Borroff , "How to Design Cars Like a Pro", Motor Books International, 2010.
3. Alan Pipes , "Drawing for Designers", Laurence King Publishing, 2007.

19AF05 SKETCHING FOR DESIGNERS

1 0 0 1

INTRODUCTION : Study of geometry of elements in products and its application in object drawing. (3)

SKETCHING : Product presentation in various media like pencil, ink and colour. - Presenting thoughts and ideas in design through sketches, perspective and exploded views. - Presentation of product design concepts through simplified graphics presentation. - Typefaces, Typography and printing - Exposure to digital photography. (12)

Total L: 15

REFERENCES:

1. Powell, Dick , "Design Rendering Techniques", Little Brown Book Group, 2008.
2. Buxton, Bill , "Sketching User Experiences: Getting the Design Right and the Right Design", Morgan Kaufmann, 2007.
3. Caplin Steve, Banks Adam , "The Complete Guide to Digital Illustration", The Ilex Press, 2003.
4. Erik Olofsson, Klara Sjölen , "Design Sketching", Keeos Design Books AB, 2005.

19AF06 INDUSTRIAL DESIGN

1 0 0 1

INTRODUCTION TO BASIC ELEMENTS : Line - texture - color - form - symmetry - balance - scale - mass - unity and variety - Concept of visual language and visual design (3)

INDUSTRIAL DESIGN : Introduction to Gestalt laws - composition and figure and ground relationships - Introduction to concept of negative space - Use of symmetry - Generation of patterns and textures using simple elements - Introduction to typography and fonts - Use of grids in graphic composition - Color circle - color combinations and its dimensions: hue - value and chroma - Color meanings in traditions and psychological use of colors. (12)

Total L: 15

REFERENCES:

1. Gail Greet Hannah , "Elements of Design", Princeton Architectural Press, 2002.
2. Itten Johannes , "The Art of Color", Wiley Publications, 2010.
3. Kepes Gyorgy , "Language of Vision", Dover Publications, 2011.
4. Elam Kimberly , "Geometry of Design: Studies in Proportion and Composition", Princeton Architectural Press, 2011.

19AF07 COMPUTER AIDED AUTOMOBILE STYLING

1 0 0 1

INTRODUCTION : Surface continuities - construction settings and its importance - curves and construction techniques - surface and surface modeling techniques - building basic volumes. (5)

COMPUTER AIDED STYLING : Sketch modeling exercise - full exterior modeling exercise - full interior modeling exercise - working with industry level class a quality - working with scan - patch planning and modeling. (10)

Total L: 15

REFERENCES:

1. Sham Tickoo , "Learning Autodesk Alias Design 2012", CADCIM Technologies, 2012.
2. Tony Lewin, Ryan Borroff , "How to Design Cars Like a Pro", Motor Books International, 2010.
3. Alan Pipes , "Drawing for Designers", Laurence King Publishing, 2007.

19AF08 VEHICLE DESIGN PROCESS

1 0 0 1

VEHICLE DESIGN PROCESS : Steps involved in design- product planning – Product Customization-concept generation- 3-D model development –design evaluation –Design based on packaging requirements - verification and validation- styling freeze- Prototype development and product testing- Accelerated testing –Environmental testing - Rapid prototyping concepts – 3D printing applications –Flexibility for up gradation- Product launch (15)

Total L: 15

REFERENCES:

1. Vivek D. Bhise , "Ergonomics in the Automotive Design Process", Third Edition, Taylor and Francis Publishers, 2009.
2. Julian Weber , "Automotive Development Processes: Processes for Successful Customer Oriented ...", Third Edition, Springer Publishers, 2012.

19AF09 ACTIVE SAFETY SYSTEMS

1 0 0 1

INTRODUCTION : Legislative Safety Requirements - ISO26262 Safety Requirements - ASIL standards. Active Safety Systems:AntilockBraking Systems - Electronic Stability Program - Traction Control Systems - Emergency Warning Braking - Adaptive Cruise Control - Sensotronic Brake Control - Brake By Wire. (9)

DRIVING SAFETY, CONDITIONAL SAFETY, PERCEPTIBILITY SAFETY, OPERATING SAFETY, PASSIVE SAFETY : Exterior safety - interior safety - deformation behavior of vehicle body - speed and acceleration characteristics of passenger compartment on impact. (6)

Total L: 15

REFERENCES:

1. Bosch , "Safety, Comfort and Convenience Systems", Jhon Wiley, 2011.
2. Powloski. J. , "Vehicle Body Engineering", Business books limited, 1969.
3. Ronald.K.Jurgen , "Automotive Electronics Handbook", McGraw-Hill Inc., 1999.

19AF10 PASSIVE SAFETY SYSTEMS

1 0 0 1

PASSIVE SAFETY SYSTEM : Introduction – SRS- Air bag system-Air bag faults- seat belts- occupant sensing systems – whiplash protection- child safety systems- pedestrian safety system- concepts and applications .- Retractable steering column- Front crash protection system- automatic door unlocking and seat belt unlocking during accident. (15)

Total L: 15

REFERENCES:

1. Ulrich Seiffert, Lothar Wech , "Automotive Safety Handbook", Third edition, SAE International, 2003.
2. Christopher Nwagboso , "Automotive Sensory Systems", Third Edition, Kluwer Academic Publishers, 2013.

19AF11 INTEGRATED PRODUCT DEVELOPMENT

1 0 0 1

INTEGRATED PRODUCT DEVELOPMENT : Product development flow diagram and timing chart - scope of vehicle development programs - verification and validation - Decomposition tree- customer need - business needs - government requirements- bench marking competitors vehicle- implementation of new technologies- design trade offs. (15)

Total L: 15

REFERENCES:

1. Vivek Bhise , "Automotive Product Development: A Systems Engineering Implementation", Fourt Edition, CRC Press, 2015.
2. Hirz Mario, Wilhelm Dietrich, Anton Gfrerrer , "integrated Computer-Aided Design in Automotive Development", Second edition, Springer, 2015.

19AF12 CAR DESIGN AND PACKAGING FUNDAMENTALS

1 0 0 1

CAR DESIGN : History of vehicle architecture in design - Design process overview - Anatomy of the package - Functions & segment - Packaging ideation - Size & proportion - Occupant packaging - Interiors & Cargo - Powertrain - Wheels & Tires - Body - Mobility. (15)

Total L: 15

REFERENCES:

1. Geoff Wardle, Stuart Macey, Ralph Gilles , "H-Point: The Fundamentals of Car Design and Packaging", Design Studio Press, 2014.
2. Sham Tickoo , "Learning Autodesk Alias Design 2016", CAD/CIM Technologies, 2016.

19AF13 AUTOMOTIVE COMMUNICATION PROTOCOLS

1 0 0 1

AUTOMOTIVE COMMUNICATION PROTOCOLS : Introduction - Vehicle communication modes- short range communication- need and applications- concepts - features- regulations - applications -A2B – Byteflight – CAN – D2B- FlexRay- LIN-MOST- Key word Protocol- SPI- VAN- J1850- Single wire – KWP 2000- AUTOSAR Regulations - Twisted pair – fibre optics- security and Privacy threats . (15)

Total L: 15

REFERENCES:

1. Nicolas Navet, Francoise Simonot-Lion. , "Automotive Embedded Systems Handbook", 4th Edition, CRC Press, London, 2008.
2. Huaqun Guo , "Automotive Informatics and Communicative Systems: Principles in Vehicular networks and data exchange", 2nd Edition, Information Science Reference, 2012.

19AF14 CHALLENGES AND ISSUES IN FUEL CELL TECHNOLOGIES

1 0 0 1

CHALLENGES AND ISSUES IN FUEL CELL TECHNOLOGIES : Introduction – cost - Durability and Reliability.- System Size- Air - Thermal and - Water Management-Improved Heat Recovery Systems- Techno –economic challenges- Material challenges – Hydrogen Storage issues –Hydration problems- Hydrogen generation – delivery infrastructure (15)

Total L: 15

REFERENCE:

1. Eshani.M, Gao. Y, Lngo. , "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", 2nd Edition, CRC Publisher, Newark, 3018.
2. Barbir F. , "PEM Fuel Cells: Theory and Practice", 2nd Edition, Elsevier, Publisher, Burlington,, 2005.

19AF15 PRODUCT DEVELOPMENT PRACTICES

1 0 0 1

GLOBAL PRODUCTS AND ITS PROBLEMS : Importance - challenges and opportunities of global products - changes and complexity in global products - global product problems - multiple causes and its effects - root cause and network of causes and measures - everyday product problems and action. (7)

PLM ENABLED PRODUCTS : : Product lifecycle management (PLM) - key characteristics and functions - benefits of PLM - metrics and targets of PLM - PLM applications and data/document management - part/product management - process/workflow management - program/project management. (8)

Total L: 15

REFERENCES:

1. John Stark , "Global Products London Ltd, 2010.", 2nd Edition, Springer-Verlag Publisher, London, 2010.
2. Mike Baxter , "Product Design", 2nd Edition, Thornes Publishers Ltd., 2009.

19AF16 PRODUCT COSTING

1 0 0 1

COMPONENTS OF PRODUCT COSTING : Raw material cost - Process cost - Assembly cost - Inspection Cost - Packing Cost - Freight Cost - Warehousing Cost - Inventory Carrying Cost - Overheads -RFQ – New Products- Ansoff's Matrix – Inputs for product costing – Volume – SOP – Customer drawing – Customer Standard –Packing methods - Delivery methods - Raw material Cost : Type of material – Grades – Condition of Raw material – Indigenous /Imported - Landed Cost – Currency rates – Taxes (8)

PROCESS COST : Process sequence -Equipments required - Machine hour rates – Interest Cost – Depreciation – Power Cost- Manpower Cost- Tool Cost- Consumable Cost- Gauge Cost – Machine maintenance Cost Packing Cost - Returnable Containers – Packing Norms - Cartons - trays - Cost Calculation - Freight - Overheads - Inventory Carrying cost -Case studies –Fixed / Variable cost - Pricing policies– Sunk Cost (7)

Total L: 15

REFERENCES:

1. Ralph S. Polimeni, Frank J. Fabozzi, Arthur H. Adelberg, Jacqueline A. Burke , "Product Costing: Concept and Applications", Third, McGraw-Hill Higher Education, 2009.
2. Ian Ryan, Birgit Starmanns , "2. Product costing and manufacturing with SAP", 2nd Edition,, Rheinwerk Publishing Incorporated,, 2015.

ENGLISH

19GF01 INTERPERSONAL AND ORGANIZATIONAL COMMUNICATION

1 0 0 1

INTRA ORGANIZATIONAL COMMUNICATION : Communication Networks in an Organization; Intra- organizational communication (2)

INTER ORGANIZATIONAL COMMUNICATION : Flow Nomenclature; Workplace diversity and intercultural aspects of communication (2)

COMMUNICATION FUNCTIONS IN ORGANIZATIONS : Teamwork and team dynamics; Conflict resolution strategies and styles; Leading and influencing others-facilitation skills (3)

WRITTEN COMMUNICATION : Email Writing, Professional Reports, and Memos (4)

INTERPERSONAL SKILLS : Nature and Dimensions of Interpersonal Communication; Personality and Communication styles; Active listening and intentional responding; Working with emotional intelligence (4)

Total L: 15

REFERENCES:

1. Bagchi Subroto , "The Professional", Penguin Publications, UK, 2011.
2. PMBOK guide , "A Guide to the Project Management Body of Knowledge", Project Management Institute Inc, USA, 2013.

19GF02 HUMAN VALUES THROUGH LITERATURE

1 0 0 1

PROSE : Kalam's vision of college education in Wings of fire - Emerson's advocacy of independence of Human will in Self-reliance - Harmony in Education-views of Bertrand Russel (4)

POETRY : Maintaining Human relations in Robert Frost's Mending Wall - Quest for identity and freedom in Kamala Das's An Introduction (2)

DRAMA : Statesmanship and friendship in Girish Karnad's Tughlaq (3)

ONE-ACT PLAY : The theme of love in Chekhov's The Bear (3)

SHORT STORY : Empathy in Somerset maugham's Mr. Know-all - Family bond in Anita Desai's Devoted son (3)

Total L: 15

TEXT BOOKS:

1. Faculty - Department of English , "Course materials", PSG College of Technology, Coimbatore, 2019.

REFERENCES:

1. Abrams M .H, Harpham , "A Glossary of Literary Terms", Cengage, Boston, 2015.
2. Scholes R, et.al. , "Elements of Literature", IV, Indian Rpt. OUP, New Delhi, 2013.

HUMANITIES

19OFA1 EXPORT – IMPORT PRACTICES

1 0 0 1

INTRODUCTION : Export – Import Business – Preliminaries for starting Export – Import Business Registration. (3)

EXPORT PROCEDURES : Obtaining an Export License – Export Credit Insurance – Procedures and Documentation (4)

FOREIGN EXCHANGE : Finance for Exports – Pricing - Understanding Foreign Exchange Rates. (3)

IMPORT PROCEDURES : Import Policy – License - Procedure and Documentation. (3)

EXPORT INCENTIVES : Incentives - Institutional support (2)

Total L: 15

REFERENCES:

1. Ramagopal C , "Export Import Procedures - Documentation and Logistics", New Age International, 2014.
2. Cherian and Parab , "Export Marketing", Himalaya Publishing House, New Delhi, 2008.
3. Parul Gupta , "Export Import Management", MC-Graw Hill, 2017.
4. Justin Paul, Rajiv Aserkar , "Export Import Management", Oxford, 2013.

19OFA2 INSURANCE - CONCEPTS AND PRACTICES

1 0 0 1

INTRODUCTION TO INSURANCE AND RISK MANAGEMENT : Origin, History, Nature and Scope of insurance – Meaning, types and significance of risk. (3)

INSURANCE LAWS AND REGULATIONS : Insurance Act, IRDA Act, Consumer Protection Act, Ombudsman Scheme. (2)

INSURANCE UNDERWRITING AND RISK MANAGEMENT : Meaning of underwriting and underwriter, guidelines and steps in the process of underwriting – characteristics, significance and principles of risk management. (4)

FINANCIAL ASPECTS OF INSURANCE MANAGEMENT : Role and functions of financial institutions, determination of premium for various insurance products. (3)

SETTLEMENT OF INSURANCE CLAIMS : Documents needed during various claims, Factors affecting insurance claims (3)

Total L: 15

REFERENCES:

1. Scott Harrington, Gregory Niehaus , "Risk Management and Insurance", McGraw Hill Education, 2017.
2. George E Rejda , "Principles of Risk Management & Insurance", Pearson Education, 2017.
3. John Hull , "Risk Management & Financial Institution", John Wiley and Sons, 2018.
4. Arjun Mittal, D D Chaturvedi , "Insurance and Risk Management", Scholar Tech Press, 2017.

190FA3 PUBLIC FINANCE

1 0 0 1

INTRODUCTION: Nature and Scope of public finance – Principles of taxation.	(2)
PUBLIC REVENUE AND TAXATION: Sources of Revenue – Tax and non-tax revenue – Classification of Taxes, GST.	(4)
PUBLIC EXPENDITURE: Importance – Types – Causes of increase in public expenditure – Effects of public expenditure in India.	(3)
DEFICIT FINANCING AND BUDGET: Sources of public debt – Debt redemption – Budget – Types – Preparation of Budget in India.	(3)
FEDERAL FINANCE: Centre-State financial relations – Finance commissions.	(3)

TOTAL: 15

REFERENCE BOOKS:

1. Richard A Musgrave and Peggy B Musgrave, "Public Finance in Theory and Practice" – Tata McGraw Hill Education, New Delhi, 2004.
2. Bhatia H.L., "Public Finance" – Vikas Publishing House, 29th Edition, New Delhi, 2012.
3. David N Hyman, "Public Finance: A contemporary application of theory and policy", Cengage Publication, 11th Edition, Noida, 2014.
4. Santhosh Dalvi and Krishnan Venkatasubramanian, "An introduction to Goods and Service Tax: The biggest tax reform in India", CCH Publisher, New Delhi, 2015.

190FA4 SECURITY ANALYSIS AND PORTFOLIO MANAGEMENT

1 0 0 1

INVESTMENT ENVIRONMENT : Financial Markets - Classification - Financial Instruments – Security Trading.	(2)
TYPES OF SECURITIES : Trading – Orders, Margin Trading – Clearing and Settlement Procedures.	(5)
SECURITY ANALYSIS I : Industry Analysis –Estimation of Rates of Return.	(2)
SECURITY ANALYSIS II : Company Analysis — Estimation of Rates of Return.	(2)
PORTFOLIO MANAGEMENT : Measuring Risk and Returns and Treatment in Portfolio Management.	(4)

Total L: 15

REFERENCES:

1. William F Sharpe, Gordon J. Alexander, Jeffery V Bailey , "Investments", Prentice Hall, 2012.
2. Prasanna Chandra , "Investment Analysis and Portfolio Management", TATA McGraw Hill Publishing, 2011.
3. Ranganathan , "Investment Analysis and Portfolio Management", Pearson, 2004.
4. Bhalla V K , "Investment Management", TATA McGraw Hill Publishing, 2011

190FA5SOCIAL ENTREPRENEURSHIP

1 0 0 1

INTRODUCTION TO SOCIAL ENTREPRENEURSHIP: Social Entrepreneur - Meaning, qualities and skills. Social Entrepreneurship – Characteristics, process and ecosystem – Case Studies.	(3)
SOURCES OF FUNDING FOR SOCIAL ENTREPRENEURSHIP: The Social Entrepreneurship Frame work. Start-ups and funding - Internal and External. Schemes for social entrepreneurship.	(4)
STRATEGIES IN SOCIAL ENTREPRENEURSHIP: Industry and Market Analysis, Business planning, concepts of value creation,new ideas and risk taking. (4)	(4)
PROSPECTS AND PROBLEMSIN SOCIAL ENTREPRENEURSHIP: Opportunities for Social entrepreneurs, an overview of legal structure, tax structure and other liabilities. (4)	(4)

TOTAL: 15

REFERENCE BOOKS:

1. S.S.Khanka, "Creativity and Innovation in Entrepreneurship", Sultan Chand & Sons, 2021.
2. C. Paramasivan, "Social Entrepreneurship", New Century Publications, 2016.
3. Robert A. Philips Margret Bonefiel Ritesh Sharma, "Social entrepreneurship, the next big business opportunity", Global Vision Publishing House, 2011.
4. Drucker, Peter, "Innovation and Entrepreneurship", Harper Business, 2006.