

B TECH in AUTOMOBILE ENGINEERING

Year	THIRD SEMESTER										FOURTH SEMESTER									
	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C		
II	MAT 2151	Engineering Mathematics – III	2	1	0	3	MAT 2252	Engineering Mathematics – IV	2	1	0	3								
	AAE 2172	Automotive Engines	3	1	0	4	AAE 2271	Automotive transmission systems	3	1	0	4								
	AAE 2159	Fluid Mechanics	3	1	0	4	AAE 2257	Linear control theory	3	1	0	4								
	AAE 2171	Materials science and Metallurgy	2	1	0	3	AAE 2272	Manufacturing Engineering and Technology	2	1	0	3								
	AAE 2173	Strength of Materials	2	1	0	3	AAE 2273	Theory of Machines	3	1	0	4								
	AAE 2158	Thermodynamics	3	1	0	4	**** *	Open Elective – I												
	AAE 2165	Automobile lab – I	0	0	3	1	AAE 2266	Automobile lab – II	0	0	3	1								
	AAE 2166	Geometric modelling lab	0	0	6	2	AAE 2267	Materials testing lab	0	0	6	2								
	Total Contact Hours (L+T+P)		15	6	9	24	Total Contact Hours (L+T+P) + OE		13	5	9	24	Total Contact Hours (L+T+P) + OE		27	3	3	30		
	FIFTH SEMESTER										SIXTH SEMESTER									
III	HUM 3151	Engg. Economics and Financial Management	2	1	0	3	HUM 3152	Essentials of Management	2	1	0	3								
	AAE 3171	Automotive chassis and suspension	3	1	0	4	AAE 3253	Finite Element Method	2	1	0	3								
	AAE 3172	Combustion and Heat Transfer	3	1	0	4	AAE 3254	Theory of Vibrations	3	1	0	4								
	AAE 3173	Design of Machine Elements	3	1	0	4	AAE ****	Program Elective – I	2	1	0	3								
	AAE 3174	Metrology and Digital Manufacturing	2	1	0	3	AAE ****	Program Elective – II	2	1	0	3								
	**** *	Open Elective – II				3	**** *	Open Elective – III												
	AAE 3165	Automobile lab – III	0	0	6	2	AAE 3265	Automotive design lab	0	0	6	2								
	AAE 3166	Numerical Simulation lab	0	0	3	1	AAE 3266	Vehicle aerodynamics lab	0	0	6	2								
	Total Contact Hours (L+T+P) + OE		13	5	9	24	Total Contact Hours (L+T+P) + OE		11	5	12	23	Total Contact Hours (L+T+P) + OE		28	3	3	31		
	SEVENTH SEMESTER										EIGHTH SEMESTER									
IV	AAE ****	Program Elective – III	3	0	0	3	AAE 4298	Industrial Training												
	AAE ****	Program Elective – IV	3	0	0	3	AAE 4299	Project Work/Practice School												
	AAE ****	Program Elective – V	3	0	0	3	AAE 4296	Project Work (Only for B.Tech honour Students)												
	AAE ****	Program Elective – VI	3	0	0	3														
	AAE ****	Program Elective – VII	3	0	0	3														
	AAE ****	Open Elective – IV				3														
	Total Contact Hours (L+T+P) + OE		15	0	0	18	Total Contact Hours (L+T+P) + OE		15	3	18		Total Contact Hours (L+T+P) + OE		15	3	18	31		

Minor Specializations

I. Automotive System Design

AAE 4035: Design of IC Engines
AAE 4036: Drive line systems of Ground vehicles
AAE 4037: Noise Vibration and Harshness
AAE 4038: Vehicle Aerodynamics

II. Electric and Hybrid vehicles

AAE 4039: Electric and hybrid vehicles
AAE 4040: Autotronics
AAE 4041: Automotive communication system
AAE 4042: Battery and Fuel cell technology

III. Material Science

PHY 4051: Physics of Low Dimensional Materials
PHY 4052: Physics of Photonic & Energy Storage Devices
CHM 4051: Chemical Bonding
CHM 4052: Chemistry of Carbon Compound

IV. Business Management

HUM 4051: Financial Management
HUM 4052: Human Resource Management
HUM 4053: Marketing Management
HUM 4054: Operation Management

V. Computational Mathematics

MAT 4051: Applied Statistics and Time Series Analysis
MAT 4052: Computational Linear Algebra
MAT 4053: Computational Probability and Design of Experiments
MAT 4054: Graphs and Matrices

Program Electives

AAE 4072: Actuation systems
AAE 4048: Artificial Intelligence and machine learning
AAE 4073: Automotive Embedded System
AAE 4074: Automotive pollution and control
AAE 4049: Bio inspired computational techniques
AAE 4050: Composite structures
AAE 4075: Computational Fluid Dynamics
AAE 4051: Computer Integrated Manufacturing
AAE 4076: Crashworthiness and safety
AAE 4077: Ergonomics in automotive design
AAE 4052: Experimental stress analysis
AAE 4053: Exploration and Mapping using Autonomous systems
AAE 4078: Farm machinery and Earth moving equipment
AAE 4054: Fracture Mechanics
AAE 4055: Global Positioning System Technology
AAE 4079: Green Energy Technology
AAE 4056: Industrial Automation
AAE 4057: Lightweight materials
AAE 4060: Operations and Supply chain Management
AAE 4062: Optimization Techniques
AAE 4064: Product design and development
AAE 4066: Robust Control
AAE 4069: Statistical Quality Control and Reliability
AAE 4070: Surface Engineering and Coating Technology
AAE 4080: Two and three-wheeled vehicles

Open Electives

AAE 4301: Automotive pollution and control
AAE 4302: Introduction to Automobile Engineering
AAE 4303: Introduction to Aerospace Engineering
AAE 4304: Introduction to Avionics and Navigation systems

THIRD SEMESTER

MAT 2151: ENGINEERING MATHEMATICS – III [2 1 0 3]

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

References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, (5e), Wiley Eastern, 1985.
2. Sastry S. S., Introductory Methods of Numerical Analysis, (2e). Prentice Hall, 1990.
3. Grewal B. S., Higher Engineering Mathematics, Khanna Publishers, 1989.
4. Murray R. Spiegel, Vector Analysis, Schaum Publishing Co., 1959.

AAE 2172: AUTOMOTIVE ENGINES [3 1 0 4]

Fundamental operating principle, classification, characteristics, four and two-stroke engines, valve and port timing diagram, scavenging system. Introduction to CI and SI engine, fuel injection equipment, combustion chambers, ignition system, mixture preparation, emission and catalyst, electronic control of engine, numerical on engine performance. valve actuating mechanism, mufflers, acoustic modelling techniques, supercharging, turbocharging, engine cooling systems, engine lubrication, Quasi-study engine instrument.

Reference:

1. Richard Stone, Introduction to internal combustion engines, Macmillan Education UK, 1999.
2. Mathur and Sharma, Internal combustion engine, Dhanpat rai publications, New Delhi, 2007.
3. Hung Nguyen-Schäfer, Rotordynamics of Automotive Turbochargers, (2e), Springer International Publishing, 2015.
4. Kirpal singh, Automobile Engineering vol II, Standard publishers, 2014.
5. John B. Heywood, Internal Combustion Engines Fundamentals, McGraw Hill, 1988.

AAE 2159: FLUID MECHANICS [3 1 0 4]

Density, Specific weight, Specific gravity, viscosity, Surface Tension, Capillarity, Vapour pressure, compressibility. Pressure at a point, Pascal's law, pressure variation with temperature, density and attitude. Hydro static law, Piezometer, Simple and differential manometers, pressure gauges, total pressure and center of pressure – plane, vertical and inclined surfaces, Buoyancy and stability of floating bodies. Stream line, path line, streak line, stream tube, classification of flows, steady, unsteady, uniform, non-uniform, laminar, turbulent, rotational, irrotational flows, one, two and three-dimensional flows – continuity equation in 3D flow, stream function, velocity potential function. Types of forces, surface and body forces – Euler's and Bernoulli's equation derivation, Impulse-Momentum equation – applications, forces on pipe bends. Similarity laws, Dimensional Analysis, Flow Measurement devices for closed and open conduits- Venturimeter, Orifice meter, Pitot/Pitot-static tubes. Open channels- notches and weirs. Reynold's experiment for closed conduit flow- laminar and turbulent. Fully

developed flows, Hagen Poiseuille equation for viscous flows, Darcy-Weisbach equation and Chezy's formula for pipe flow. Major and Minor energy losses. Multiple pipe systems- series and parallel. Free stream velocity, Streamlined and bluff bodies, Boundary layer theory, Bernoulli's equation for compressible flows, the velocity of the sound wave in a fluid for the isothermal and adiabatic process, Mach number and its applications, Propagation of Pressure waves and stagnation properties.

Reference:

1. Yunus Cengel, John M Cimbala, Fluid Mechanics, Tata Mcgraw-Hill Publications, New Delhi, 2013.
2. Frank N. White, Fluid Mechanics, Tata Mcgraw-Hill Publications, New Delhi, 2011.
3. Bruce R. Munson, Theodore H. Okiishi, Wade W. Huebsch, Alric P. Rothmayer, Fundamentals of Fluid Mechanics, John Wiley and Sons, New Jersey, 2013.
4. Clayton T. Crowe, Donald F. Elger, Barbara C. Williams, John A. Roberson, Engineering Fluid Mechanics, John Wiley and Sons, New Jersey, 2009.

AAE 2171: MATERIALS SCIENCE AND METALLURGY [2 1 0 3]

Introduction to crystal structures and imperfections, Miller indices and brevis lattice. Crystal structure determination-X-ray diffraction techniques, Microscopic examination. Strengthening mechanisms - solid solution strengthening. Work hardening - recovery recrystallisation and grain growth. Cast iron, steels, alloy steels, iron – iron carbide equilibrium diagram. Steels and cast irons, stainless steels - types, specific applications. Aluminium, Magnesium and Titanium alloys. Wrought and cast alloys used in automotive applications - Types, specifications. Definitions, Full annealing, spheroidizing, normalising, hardening and tempering of steel. Isothermal transformation diagrams, cooling curves, Hardenability, Jominy end quench test, Austempering, martempering. Mechanical surface treatment and coating Case hardening and hard facing, thermal spraying, vapour deposition, iron implantation. Diffusion coating Electroplating and Electro less Conversion coating– laser-based surface modification. Lightweight materials, Micro-alloyed, high strength low alloy steel - High strength, advanced High Strength and Ultra-high strength Steels. Composite Materials, Introduction to SMART Materials, shape memory alloys (SMA), Piezo-electric materials, MEMS, Metallic glass Quasi crystal and Nanocrystalline materials, biomaterials, metal foams.

References:

1. Sydney H. Avner, Introduction to Physical Metallurgy, (2e), McGraw Hill Education (India) Pvt. Ltd, 2017.
2. Polmear I. J. David StJohn, Jian-Feng, Nie Ma Qian, Light Alloys: Metallurgy of Light Metals, (5e), Butterworth-Heinemann 2017.
3. Sharma C. P., Engineering Materials: Properties and applications of Metals and alloys, PHI, 2003.
4. Bhargava A. K., Engineering Materials: Polymers, ceramics and composite, PHI, 2012.
5. Bandyopadhyay A. K., Nano Technology, New age international publishers, 2017.

AAE 2173: STRENGTH OF MATERIALS [2 1 0 3]

Stress, strain and deformation of solids: Tension, Compression and Shear Stresses, Deformation of simple and compound bars, Thermal stresses, Elastic constants, Volumetric strains, principal stresses and principal planes, strain rosette, Mohr's circle of stress. Bending moment and shear force: Different types of beams, shear force and bending moment diagrams relationship connecting intensity of loading, shear force and bending moment diagrams for statically determinate plane

frames. Torsion: Torsion of circular solid and hollow shafts - power transmission - strain energy in shear and torsion - close coiled and open coiled helical springs. Deflection of beams: Double Integration method, Macaulay's method, Area moment method for computation of slopes and deflections in beams, Conjugate beam and strain energy, Maxwell's reciprocal theorems. Thin cylinders, spheres and thick cylinders: Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders, spherical shells subjected to internal pressure, Deformation in spherical shells, Lamé's theorem.

References:

1. Mott, Applied Strength of materials, PHI, 1998.
2. Egor P Popov, Engineering Mechanics of Solids, PHI, 2004.
3. Norman E. Dowling, Mechanical Behavior of Materials: Engineering Methods for Deformation, Fracture, and Fatigue, Pearson Education, 2013.
4. Bhavikatti, S.S., Strength of Materials, (4e), Vikas Publishing House Pvt. Ltd, 2013.
5. Das Madan Mohan, Saikia Mimi Das, Das Bhargab Mohan, Basic Engineering Mechanics and Strength of Materials, PHI Learning Pvt. Ltd, 2010.

AAE 2158: THERMODYNAMICS [3 1 0 4]

Vocabulary associated with thermodynamics, basic concepts of thermodynamics like the system, properties, equilibrium, pressure, specific volume, temperature, zeroth law of thermodynamics, temperature measurement and temperature scales ideal gas and pure substance. thermodynamic properties using tables of thermodynamic properties and analyze the processes on T-v diagrams to solve advanced engineering problems. first law of thermodynamics for closed and open systems undergoing different thermodynamic processes. use of the first law to understand its application for open systems such as turbine, nozzle and heat exchanger. the second law of thermodynamics. formulation of entropy principle from the second law of thermodynamics for a cycle by establishing the inequality of Clausius. the inequality of Clausius and establish the property entropy of a system. various power cycles and comparison of the otto, diesel, and dual cycle performance. Estimate the efficiency of Brayton cycle for various engineering case studies.

References:

1. Van Wylen G. & Sonntag R.E., Fundamentals of Classical Thermodynamics, John Wiley Pub, 1997.
2. Jones J.B., & Dugan R.E., Engineering Thermodynamics, Prentice Hall, 1996.
3. Yunus Cengel & Boles, Thermodynamics – An Engineering Approach, (7e), TMH, 2000.
4. Holman J. P, Thermodynamics, McGraw Hill International, 1985.
5. Nag P. K., Engineering Thermodynamics, (3e), Tata McGraw Hill, 1998.

AAE 2165: AUTOMOBILE LAB - I [0 0 3 1]

Engine systems identification, servicing of air filter, fuel and oil filters, rocker shaft, oil pump, piston and connecting rod assembly, Valve refacing and lapping, valve seat cutting, cylinder reboring, honing, crankshaft regrinding, line boring.

References:

1. Kirpal Singh, Automobile Engineering vol II, Standard publishers, 2014.
2. Giri N. K., Automobile Mechanics, Khanna publications, New Delhi, 2005.

AAE 2166: GEOMETRIC MODELLING LAB [0 0 6 2]

Introduction to 2D entities, Mechanical Components, Automotive components, Introduction to 3D Entities, Introduction to Assembly commands, Automotive Components assembly, Rocker Arm Assembly, Plummer block assembly, IC Engine Connecting rod, Engine Cross Head, Screw Jack

References:

1. Sham Tickoo, CATIA V5R17 for engineers & Designers, Dreamtech Press Publication, 2008.
2. Michael Michaud, CATIA Core Tools: computer-aided three-dimensional interactive application, McGraw Hill Professional Publication, 2012.
3. Kirstlie Plantenberg, An Introduction to CATIA V6 Release 2012, Schroff Development Publication, 2011.

FOURTH SEMESTER

MAT 2252: ENGINEERING MATHEMATICS – IV [2 1 0 3]

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

References:

1. Erwin Kreyzig, Advanced Engineering Mathematics (7e), Wiley Eastern, 2011.
2. Meyer P. L., Introduction to probability and Statistical Applications, (2e). American Publishing Co, 1970.
3. Grewal B. S., Higher Engineering Mathematics, Khanna Publishers, 1989.
4. Hamdy A Taha, Operation research, (9e), Pearson, 2014.

AAE 2271: AUTOMOTIVE TRANSMISSION SYSTEMS [3 1 0 4]

Necessity, layouts of various transmission systems w r t engine position and drive transmission. Power required for propulsion, resistances encountered, maximum acceleration, tractive effort and reactions for different wheel drives, critical speed for stability of vehicles, effective weight of automobile, power to weight ratios, Clutches, friction and fluid, gearboxes, drive shafts, critical speeds of shafts, constant velocity and variable velocity U joints, differentials and final drive systems. Automatic transmission systems, hydramatic and CVT systems, torque converters, hydraulic control systems, Ford Hydramatic transmission systems, Electronically controlled automatic transmission systems, Hydrostatic drive systems, different pumps and motors for hydrostatic drive systems.

References:

1. Kenneth Garrett, Kenneth Newton, W steeds, The motor vehicle, (13e), Butterworth-Heinemann Ltd, London, 2005.
2. Joseph Heitner, Automotive mechanics, (2e), PHI publishers, 2006.
3. Jack Erkavec, Automotive Engineering- Automatic Transmission & transaxles, classroom and shop manual, Cengage learning India Pvt Ltd, 2011.
4. Jack Erkavec, Automotive Technology- Manual transmission, Cengage learning India Pvt Ltd, 2011.

5. Heinz Heisler, Advanced vehicle technology, (2e), Butterworth-Heinemann, New York, 2002.

AAE 2257: LINEAR CONTROL THEORY [3 1 0 4]

Mathematical Modelling of System, Laplace Transforms, transfer functions, block diagram representation, Block diagram reduction, Time response characteristics. Introduction to stability, Routh Hurwitz stability criterion. Root locus plots, stability margins. Frequency response analysis: Nyquist stability criterion, Bode plots and stability margins in the frequency domain. Basics of control design, the proportional, derivative and integral actions. Design using Root Locus Design using Bode plots Effects of zeros, minimum and non-minimum phase systems. Introduction to state space methods, Linearization of nonlinear systems.

References:

1. Katsuhiko Ogata, Modern Control Engineering, (5e), Pearson Education Inc, 2010.
2. Nagrath I. J. and Gopal M., Control Systems Engineering, (4e), New Age Publications, 2015.
3. Farid Golnaraghi and Benjamin C Kuo, Automatic Control Systems, (9e), John Wiley and Sons, 2009.
4. Harry Trentelman, Anton A. Stoorvogel, Malo Hautus, Control Theory for Linear Systems, Springer-Verlag, 2001.

AAE 2272: MANUFACTURING ENGINEERING AND TECHNOLOGY [2 1 0 3]

Manufacturing: introduction and economic significance, manufacturing systems and functions ,Casting processes: analysis of melting, pouring and solidification phenomena; design of pattern, core, riser and gating system; dispensable and permanent mold processes, casting defects and inspection, injection molding process, Powder processing: powder manufacture, characterization, compaction and sintering; metal injection molding, hot and cold isostatic pressing, Bulk and Sheet Forming processes: rolling, forging, extrusion and drawing; sheet metal working; load calculations for bulk and sheet metal processing; forming defects, Joining processes: fusion and solid-state welding; brazing and soldering; weld joint design, heat affected zone and joint properties, friction stir welding, welding of dissimilar metals, welding defects and inspection., Material Removal Processes: chip formation, cutting tool inserts, tool wear, tool life, Machine tools, CNC Technology, Advanced machining processes: Abrasive water jet machining, EDM, ECM, LASER machining, Additive Manufacturing: process chain and overview, classifications, Fused Model Deposition, Stereolithography, Polyjet materials printing, Selective Laser Sintering, Selective Laser Melting, Electron Beam Melting , Laser Engineered Net Shaping, Production tooling, Jigs and fixtures, principles of location and clamping, production process plan, Case studies of automotive component manufacturing.

References:

1. Mikell P Groover, Fundamentals of modern manufacturing, Materials, Processes, and Systems, (6e), John Wiley, 2015.
2. Serope Kalpakjian, Steven R. Schmid, Manufacturing Engineering and Technology, (7e), Pearson Education, 2013.
3. Degarmo Paul, Black, Kohser, Materials and Processes in Manufacturing, (12e), Wiley, 2017.
4. Gibson, Ian, Rosen, David, Stucker, Brent, Additive Manufacturing Technologies, (2e), Springer, 2015.

AAE 2273: THEORY OF MACHINES [3 1 0 4]

Mechanism and inversions. Degrees of freedom. Mathematical analysis of velocity and accelerations of simple mechanisms. Synthesis of cams and gears. Gear trains. Static and dynamic force analysis of linkages.

Balancing of rotating and reciprocating masses. Governors and its characteristics. Gyroscope and gyroscopic effect on automobiles.

References:

1. Uicker J. J., Pennock G. R. and Shigley J. E., Theory of Machines and Mechanisms, Oxford University Press, 2011.
2. Amitabh Gosh, Asok Kumar Malik, Theory of Mechanisms and Machines, East-West Publishers, 2006.
3. Rao J. S., Dukkupati R. V. Mechanisms and Machines Theory, New Age Int., 2007.
4. Rattan S. S. Theory of Machines, Tata Mc Graw Hill, 2008.
5. Ambekar, Theory of Machines and Mechanisms, Prentice Hall India, 2008.

AAE 2266: AUTOMOBILE LAB - II [0 0 3 1]

Clutches, gearbox, final drive and differential, master cylinder, wheel cylinder, steering gear and linkages. Lighting circuits, spark plug testing, headlamp alignment, starter motor, alternators, testing of battery, horn and wiper

References:

1. Kirpal Singh, Automobile Engineering vol II, Standard publishers, 2014.
2. Giri N. K., Automobile Mechanics, Khanna publications, New Delhi, 2005.
3. Rajput R. K., Automobile Engineering, Lakshmi publications(Pvt) Ltd, New Delhi, 2008.

AAE 2267: MATERIAL TESTING LAB [0 0 6 2]

Introduction-Tensile test, load displacement and Stress-Strain curves, Torsion Test, Compression Test, Bending Test, Impact Test, Impact test: Izod and Charpy Test, Hardness Test, Brinell and Rockwell test, Fatigue and Shear Test, Test on Helical Spring, Non-destructive testing.

References:

1. Bhavikatti, S.S., Strength of Materials, (4e), Vikas Publishing House Pvt. Ltd, 2013.
2. Egor P Popov, Engineering Mechanics of Solids, PHI, 2004.
3. Norman E. Dowling, Mechanical Behaviour of Materials, Pearson Education, 2010.

FIFTH SEMESTER

HUM 3151: ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT [2 1 0 3]

Nature and significance, Micro & macro differences, Law of demand and supply, Elasticity & equilibrium of demand & supply. Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of single, Uniform gradient cash flow. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with the return, Rate of return method, an Incremental approach for the economic analysis of alternatives, Replacement analysis. Break-even analysis for single product and multi-product firms, Break-even analysis for evaluation of investment alternatives. Physical & functional depreciation, Straight-line depreciation, Declining balance method of depreciation, Sum-of-the-years digits method of depreciation, Sinking fund and service output methods, Costing and its types – Job costing and Process costing, Introduction to balance sheet and profit & loss statement. Ratio analysis - Financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios

References:

1. Prasanna Chandra., *Fundamentals of Financial Management*, Tata Mc-Graw Hill Companies, New Delhi, 2005.
2. James L Riggs, David D Bedworth and Sabah U Randhawa., *Engineering Economics*, Tata McGraw – Hill Publishing Company Ltd, New Delhi, 2004.
3. T. Ramachandran., *Accounting and Financial Management*, Scitech Publications Pvt. Ltd. India, 2001.
4. Eugene F. B. & Joel F. H., *Fundamentals of Financial Management*, 12th ed., Cengage Learning Publisher, 2009.
5. M. Y. Khan & P. K. Jain., *Financial Management*, 5th edition Tata McGraw Hill Publication, New Delhi, 2008.
6. Thuesen G.J., *Engineering Economics* Prentice Hall of India, New Delhi, 2005.
7. Blank Leland T. Tarquin Anthony J. *Engineering Economy*, McGraw Hill, Delhi, 2002.
8. Chan S. Park, *Fundamentals of Engineering Economics*, 3rd edition, Pearson Publication, 2013.

AAE 3171: AUTOMOTIVE CHASSIS AND SUSPENSION [3 1 0 4]

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

References:

1. Newton K., Steeds W., Garrett T. K., The Motor Vehicle, SAE Publications, 2004.
2. Joseph I Heitner, Automotive mechanics principles and practice, CBS Publishers and distributors, 2004.
3. Banga T. R. & Nathu Singh, Automobile Engineering, Khanna Publishers, 2007.
4. Rajput R. K., Automobile Engineering, Laxmi Publications (P) Ltd, 2008.

AAE 3172: COMBUSTION AND HEAT TRANSFER [3 1 0 4]

Introduction to combustion processes- Classification of flames, Auto Ignition temperature, Combustion in SI and CI engines, Introduction to heat transfer- modes of heat transfer, combined modes, conductivity and film coefficient of heat transfer, Thermal diffusivity, overall heat transfer coefficient, thermal resistance and conductance. Conduction Heat Transfer-Linear heat flow through Plane Wall, Composite Walls, radial heat flow through cylinder, Composite Cylinders, radial heat flow through Sphere and Composite spheres, Effect of Variable thermal conductivity, Critical thickness of insulation, Heat Transfer from Extended Surfaces, Convection Heat Transfer- Application of dimensional analysis to free and forced convection, Dimensionless numbers, Hydrodynamic and thermal boundary layer, Boiling heat transfer, Heat Exchangers- Types, overall heat transfer coefficient, fouling or scaling and fouling factor. Logarithmic mean temperature difference, correction factor. Effectiveness and Number of transfer units, Radiation-Black Bodies, emissive power, the intensity of radiation, heat transfer due to radiation between black bodies and grey bodies.

References:

1. Nag P. K., Heat and Mass Transfer, Tata Mcgraw Hill Education Pvt Ltd, New Delhi, 2011.
2. Yunus Cengel and Afshin Ghajar, Heat and Mass Transfer, Tata McGraw Hill Education Pvt Ltd, New Delhi, 2001.
3. Som S. K., Introduction to Heat Transfer, PHI Learning Pvt Ltd, New Delhi, 2008.

- Ganesan V., Internal Combustion Engines, Tata Mcgraw-hill Education, New Delhi, 2012.
- Mathur M. L. and Sharma R. P., Internal Combustion Engines, Dhanpat Rai Publications, New Delhi, 2011.

AAE 3173: DESIGN OF MACHINE ELEMENTS [3 1 0 4]

Coil Springs- Helical-cylindrical compression/extension springs of round/square/ rectangular wires, spring materials, Stress & deflection of springs subjected to steady, Fluctuating & impact loads, Energy stored in springs, Critical frequency, Concentric springs. Leaf Springs- Semi-elliptic carriage springs, Deflection, Stresses in full length & graduate leaves, Combination of leaf & coil springs. Spur Gears- Standard involute gears, Beam strength of tooth, Lewis' equation, Form factor & velocity factor, Stress in gear teeth, Dynamic loads on gear teeth, Wear Strength. Helical Gears- the Formative number of teeth, Helix angle, Face width, Velocity factor, Static Strength, Dynamic strength, Wear strength. Bevel Gears-Straight teeth bevel gears, Cone angle, Virtual number of teeth, Face width, Static strength, Dynamic Strength, Wear Strength. Worm Gears- Nomenclature, Materials, Reversibility, Mechanical advantage, Strength design, Efficiency, Heat dissipation. Sliding Contact Bearings, Journal bearings, Viscosity and lubricants, bearing characteristic number, Somerfield number, Coefficient of friction, Bearing modulus, Mechanism of film lubrication, Minimum oil film thickness, Temperature rise, Oil flow, Heat generation & dissipation. Rolling Contact Bearings-Types of the ball and roller bearings, Life rating, Basic capacities, Equivalent load, Loading ratio. Belt Drives- Power transmission, Flat and V belts, Ratio of belt tensions, Centrifugal tension, Factors, Power rating, V-flat drives, Pulleys, Selection of belts and pulleys. Fatigue and Creep

References:

- Norton R.L., Machine Design: An Integrated Approach, (4e), Pearson, 2010
- Shigley J., Mechanical Engineering Design, McGraw Hill New York, 2016.
- Spotts M.F., Shoup E.T., Hornberger L.E., Design of Machine Elements, (8e), Pearson 2003.
- Bhandari V. B., Design of Machine Elements, (3e), Tata McGraw Hill Publishing Company, New Delhi, 2012.
- Mahadevan K. & Balaveera Reddy K., Design Data Handbook, CBS Publishers and Distributors, New Delhi, 2010.

AAE 3174: METROLOGY AND DIGITAL MANUFACTURING [2 1 0 3]

International Vocabulary in Metrology (VIM), essential terms and interpretations, unit, accuracy, precision, sensitivity, systematic and random errors, traceability, calibration, introduction to uncertainty, type A and type B uncertainty, combined standard uncertainty, coverage factor and expanded uncertainty, ISO method for the quantification and reporting of uncertainty, uncertainty and calibration, uncertainty and product specifications, product conformity assessment, Geometrical Dimensioning and Tolerancing, GDT symbols and interpretations, GDT rules, datum, MMC, LMC, virtual condition, reading and interpreting blue prints, limits ,fits and tolerances, ISO tolerance class, assembly tolerance, assembly shift ,tolerance stack up analyses: worst case and statistical analyses, linear and angular measurements, gauges, gauge design, CMM: constructional features and measurement strategy, Surface roughness, waviness , 2D and 3D parameters , bearing ratio curve, measurements of roughness, form errors and form testing device, roundness, measurement, 3D scanners and laser trackers, Measurement Systems Analyses, bias, linearity, stability, repeatability and reproducibility, reporting Gauge R and R, Digital Manufacturing and Design, Industry 4.0, Industrial IoT, Cyber Physical Systems, sensor interfacing, communication protocols, M2M technology, scanning to modelling to fabrication, Digital Thread, Digital Twin, Data Procurement

Standards, Digital Manufacturing Commons, Model-Based Systems Engineering, Digital Manufacturing Security, Intelligent Manufacturing.

References:

- Les Kirkup and Bob Frenkel, An Introduction to Uncertainty in Measurement, Cambridge University Press, 2006.
- Mark A. Curtis and Francis T. Farago, Handbook of Dimensional Measurement, Industrial Press, 2014.
- David Whitehouse, Surfaces and their measurement, Butterworth-Heinemann, 2004.
- Gene R. Cogorno, Geometric Dimensioning and Tolerancing for Mechanical Design, McGraw-Hill, 2012.
- Bryan R. Fischer, Mechanical Tolerance Stack-up and Analysis, CRC Press, 2004.

AAE 3165: AUTOMOBILE LAB - III [0 0 6 2]

Thermomechanical lab, Lathe operations, turning, taper turning, thread cutting, gear hobbing, CNC programming, Grinding. Determination of viscosity, flash and fire points, compression ratio, obtaining the valve timing diagrams, performance test on petrol and diesel engines, Morse test, Refrigeration test rig.

References:

- Lab manuals
- Ganesan V., Internal Combustion Engines, Tata Mcgraw-hill Education, New Delhi, 2012.
- Mathur M. L. and Sharma R. P., Internal Combustion Engines, Dhanpat Rai Publications, New Delhi, 2011.

AAE 3166: NUMERICAL SIMULATION LAB [0 0 3 1]

Numerical computation-MATLAB, SIMULINK & LabVIEW, Linear Algebraic Systems and Mass-Spring-Damper Systems, Eigenvalues and Eigenvectors-Matrices, Characteristic Polynomial and Telescope Position Control, Curve fitting and Nonlinear friction Model, Root finding and Suspension cable, Optimization and transportation planning, Differentiation and Integration-Link of robotic Arm, Ordinary Differential Equations-Euler's Method, Runge-Kutta Methods, Multistep, Boundary Value Problems-Chemical Reactor, UAV dynamics, Partial Differential Equations, Twisted Bar, Aircraft Simulation & Systems Identification, LabVIEW-Basic Circuit Design and Analysis, Mini Project-Aircraft Design & Simulation, aerospace, automobile, robotics process simulation, MATLAB/SIMULINK, LabVIEW, Robots, UAV telemetry.

SIXTH SEMESTER

HUM 3152: ESSENTIALS OF MANAGEMENT [2 1 0 3]

Definition of management and systems approach Nature & scope, The functions of managers, Corporate social responsibility. Planning: Types of plans, Steps in planning, Process of MBO, How to set objectives, Strategies, Policies & planning premises, Strategic planning process and tools. Nature & purpose of behaviour, Span of management, factors determining the span, Basic departmentalization, Line & staff concepts, Functional authority, Art of the delegation, Decentralisation of authority. HR planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques. Leadership – leadership behaviour & styles, Managerial Grid. Basic Control Process, Critical Control Points & Standards, Budgets, Non-budgetary control devices. Profit & loss control, Control through ROI, Direct, Preventive control. Managerial practices in Japan & USA & application of Theory Z. The nature & purpose of international business & multinational corporations, the unified global theory of management. Entrepreneurial traits, Creativity, Innovation management, Market analysis, Business plan concepts, Development of financial projections

References:

1. Koontz D., Essentials of Management, Mc Graw Hill, New York, 2004.
2. Peter Drucker, Management, Task and Responsibility, Allied Publishers, 2006.
3. Peter Drucker, The practice of management, Butterworth Hein Mann, 2003.

AAE 3253: FINITE ELEMENT METHOD [2 1 0 3]

Introduction to Finite Element Method, Difference between Finite Element and, Finite Difference Methods, steps in Finite element method, Displacement, one dimensional elements, derivation of bar element, beam element, spring element stiffness matrix, bar element orientation, beam element with UDL, hinge condition, 2D plane element, constant strain triangle, linear strain triangle elements, energy method, weighted residual method.

References:

1. Reddy J. N., An Introduction to Finite Element Method, McGraw Hill Publication, 2003.
2. Segerlind L. S., Applied Finite Element Analysis, John Wiley & Sons, 1998.
3. Rao S. S., The Finite Element Method in Engineering, Pergamon, 2004.
4. Logan D., The First course in finite element method, Cengage Learning, 2016.

AAE 3254: THEORY OF VIBRATIONS [3 1 0 4]

Introduction to Vibrations terminology. SDOF –undamped and damped free vibrations. SDOF systems subjected to forced vibration. 2DOF systems: Natural frequencies and modes of vibration by the classical method of the spring-mass system, Coordinate coupling. Dynamic vibration absorber, pendulum absorber. MDOF systems-influence coefficients. Matrix method, Numerical methods. The vibration of continuous systems and Critical speeds of shafts, critical speed of shafts with damping. Importance of NVH in automobiles- tailpipe noise measurement and vehicle pass by noise measurement. Introduction to Modal analysis- Impact hammers, Electrodynamics shakers, microphones and their applications in Automobile Industries.

References:

1. Singirisu Rao S., Mechanical Vibration Pearson Education, Delhi, 2004.
2. Dukkappatti Rao V., Text Book of Mechanical Vibration, Prentice Hall of India Ltd, 2004.
3. Daniel Imnan J., Engineering Vibration Prentice Hall, New Delhi, 2001.
4. Groover G. K., Mechanical Vibrations Nemchand And Bros, Roorkee, 2001.
5. Thomson W. T., Theory of Vibrations with Applications, (4e), Chapman and Hall, 1993.

AAE 3265: AUTOMOTIVE DESIGN LAB [0 0 6 2]

Introduction to ANSYS, Introduction to elements, One Dimensional element: Beam, Truss, Two-Dimensional modelling analysis, Shell Elements, 2D Solid Elements, 3D Solid Element and Analysis, thermal analysis, aerodynamic analysis, a crash test of vehicles.

References:

1. Choudary R. B., Introduction to ANSYS10.0, I K International, 2009.
2. Esam M. A., Finite element simulation using ANSYS, Taylor & Francis Publication, 2010.

3. Paleti Srinivas, Krishna Chaitanya S ambana, Rajesh Kumar Datti, Finite element using ANSYS 11.0, PHI Publications, 2010.
4. Stolavski T, Nakasone Y, Yoshimoto S, Engineering analysis with Ansys software, Butterworth-Heinemann Publication, 2006.

AAE 3266: VEHICLE AERODYNAMICS LAB [0 0 6 2]

Introduction-Calibration of the wind tunnel, Aerodynamic analysis of different body, Drag of different bodies, Pressure distribution over an aerofoil at a different angle of attacks, Measurement in wind tunnel such as Boundary Layer measurements, Wake survey method, Flow Visualization Techniques, Six component balance.

References:

1. Hucho W. H., Aerodynamic of Road Vehicles, Butterworths Co Ltd, 1997.
2. Pope A., Wind Tunnel Testing, (2e), John Wiley & Sons, Newyork, 1947.
3. Lab Manual, Wind Tunnel Manual.

SEVENTH SEMESTER

There are five program electives and one open elective with a total of 18 credits to be taught in this semester.

EIGHTH SEMESTER**AAE 4298: INDUSTRIAL TRAINING**

Each student has to undergo industrial training for a minimum period of 4 weeks. This may be taken in a phased manner during the vacation starting from the end of the third semester. The student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

AAE 4299: PROJECT WORK/PRACTICE SCHOOL

The project work may be carried out in the institution/industry/ research laboratory or any other competent institutions. The duration of the project work shall be a minimum of 16 weeks which may be extended up to 24 weeks. A mid-semester evaluation of the project work shall be done after about 8 weeks. An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation. The final evaluation and viva-voice will be conducted after submission of the final project report in the prescribed form. The student has to make a presentation on the work carried out, before the department committee as part of project evaluation.

PROGRAM ELECTIVES**AAE 4035: DESIGN OF IC ENGINES [2 1 0 3]**

Principle parts of an IC Engine, systems of the engine, working overview. Features of cylinders, dry and wet liners, the design of a cylinder, cylinder thickness, bore and stroke, flange and stud design, the thickness of cylinder head, problems on the cylinder and head design. Function, Materials, Constructional details and design considerations for a piston, design procedure considering the gas loads, thickness at the head, open end, barrel, land, grooves, skirt, design of piston rings and piston pin. Problems with piston design. Functions, materials, types, forces acting on connecting rods, the design of connecting rod small end, large end, shank, big end cap and bolts, problems on connecting rod design. Functions, materials and manufacture, forces acting, bearing pressure and stresses in shafts, types of crankshafts, the design of centre

crankshaft and over hung crankshaft, problems on crankshaft design. Different types of mechanisms, valve requirements, materials, design, thickness of valve disc, stem diameter, valve lift, rocker arm cross-section and shaft design, tappet design, valve spring design problems on valves, the design of fulcrum pin, push rods. Function, types, materials, design of flywheels, problems on flywheel design.

References:

1. Bhandari V. B., Design of Machine Elements, Tata Mcgraw Hill Education, 2010.
2. Kevin L. Hoag, M. S, Vehicular Engine Design, Springer-Verlag, Wien, and the SAE International, 2006.
3. Newton K, Steeds W, Garrett TK, The Motor Vehicle, SAE Publications, 2004.
4. Shigley J., Mechanical Engineering Design, McGraw Hill, SI-FPS Edition, 1980.
5. Ganesan V., Internal Combustion Engines. Tata Mc Graw hill publishing co ltd, 2008.

AAE 4036: DRIVELINE SYSTEM OF GROUND VEHICLES [2 1 0 3]

Outlines of Power Trains, Powertrain functions, Powertrain layout and components, Main and Auxiliary functions, Requirements profile, Interrelations: Direction of rotation, Transmission Ratio and Torque, Road Profiles, Load Profiles, Typical Vehicle uses and Driver types, Performance features of Vehicle Transmissions. Design trends in Transmission, Numerical problems. Matching engine and transmission: Traction diagram, vehicle performance, fuel consumption, emission, the dynamic behaviour of the powertrain, comfort, Numerical problems. The arrangement of transmission in a vehicle, transmission format and design, basic gearbox construction, gear sets with a fixed axle, countershaft transmission and epicyclic gear, passenger car transmission, commercial vehicle transmission, transfer gearbox and power take-off, final drives, differential gears, differential locks and locking differential. Systematic classification of shifting elements, synchronizer functional requirements, synchronizing process, the design of synchronizer, engineering design, alternative transmission synchronizer. Principles, Characteristic curves of Hydrodynamic Clutches, Construction and operation of Torque Converter, Input/output characteristics, Design Considerations, Trilok Converter, Torque Converter test diagram, Interaction of engine and Trilok Converter, Numerical problems. Manual gearboxes, semi-automatic manual gearboxes, dual clutch transmission, fully automatic gearboxes, continuously variable transmission, final drives, differential gears, locking differential, four-wheel drive, transfer gearboxes. Truck transmission, bus transmission, tractor transmission, motorcycle transmission, racing transmission. Design of slip joint, universal joint, dead & live axle, constant velocity joints, Bearing Design, Selection of ball and roller bearing, Gearbox housing design.

References:

1. Gisbert Lechner, Harald Naunheimer, Automotive Transmissions: Fundamentals, Selection, Design and Application, Springer- Verlag Berlin Heidelberg, New York, 1999.
2. Robert Fischer, et al, Automotive transmission book, Springer International Publishing Switzerland, 2015.
3. Alec Stokes, Manual gearbox design, SAE, 1992.
4. Design Practices: Passenger Car Automatic Transmissions, (3e), AE-18, SAE, Warrendale, 1994.
5. Fenton J., Handbook of Automotive Powertrain and Chassis Design, Professional Engineering Publishing, London, 1998.

AAE 4037: NOISE VIBRATION AND HARSHNESS [2 1 0 3]

Fundamentals of Vehicle Vibrations and sound- basics of vibrations and sound, analysis of test procedures. Power-train vibrations and sound-engine vibrations and noise, transmission vibrations and noise and isolation. Vibrations and sounds of body and chassis systems- Interior noise, structure-borne noise, wind noise, rattle and vehicle low-frequency vibrations. Evaluation of vehicle vibrations and sound- noise and sound quality evaluation and vibration evaluation.

References:

1. Gang Shen, Vehicle Noise, Vibration and Sound Quality. SAE International, Warrendale, Pennsylvania, 2012.
2. Sujatha C., Vibration And Acoustics, Tata McGraw Hill publication, 2010.
3. Matthew Harrison, Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles, Mathew Harrison Publication, 2004.
4. Malcolm J Crocker, Handbook of Noise and Vibration Control, John Wiley & sons Publication, 2007.
5. Anton Fuchs, Eugenius and Hans, Automotive NVH Technology, Springer publication, 2016.

AAE 4038: VEHICLE AERODYNAMICS [2 1 0 3]

Historical development trends - Fundamental of fluid mechanics - Flow phenomenon related to vehicles - External & Internal flow problem - Resistance to vehicle motion - Performance - Fuel consumption and performance - Potential of vehicle aerodynamics. Cars as a bluff body - Flow field around the car - drag force - types of drag force - analysis of aerodynamic drag - drag coefficient of cars - strategies for aerodynamic development - low drag profiles. Front-end modification - front and rear windshield angle - Boat tailing - Hatchback, fastback and square back, Dust flow patterns at the rear - Effects of gap configuration - the effect of fasteners. The origin of forces and moments on a vehicle - side wind problems - method to calculate forces and moments - vehicle dynamics underside winds - the effects of forces and moments - Characteristics of forces and moments - Dirt accumulation on the vehicle, wind noise - drag reduction in commercial vehicles. The 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.

References:

1. Hucho W. H., Aerodynamics of Road vehicles, SAE International Publications, 2006.
2. Barnard R. H., Road vehicles aerodynamics Desing - an introduction, MechAero Publishing, 2009.
3. Mark Gleason, Vehicle aerodynamics design and technology, Society of Automotive Engineers, Incorporated, 2001.

AAE 4039: ELECTRIC AND HYBRID VEHICLE [2 1 0 3]

Overview of electric vehicles, hybrid vehicles, hybrid and electric vehicle components, vehicle mass and performance, electric motor and engine ratings, EV and ICEV comparison, vehicle kinetics, dynamics of vehicle motion, propulsion power, velocity and acceleration. Tyre road force mechanics. Propulsion system design. Electric vehicle architecture, hybrid vehicle architecture. Hybrids based on the degree of hybridization. Plug-in the hybrid electric vehicle. Power train component sizing. vehicle simulation (simulation model, standard drive cycles). Electric machine fundamentals (motional voltage, EMF), simple DC machines (induced voltage, force and torque, DC machine back emf and torque, simple reluctance motor). DC machines, Three phase AC machines. Induction machines. Permanent magnet machines. Switched reluctance machines. Power electronic switches. DC/DC converters. case studies on EVs and HEVs.

References:

1. Halderman James D Haldeman, Hybrid and Alternative Fuel Vehicles, (2e), Pearson. Education, 2012.
2. Iqbal Hussain, Electric and Hybrid Vehicles: Design Fundamentals, (2e), CRC Press, 2010.
3. Allen E. Fuhs, Hybrid Vehicles and the Future of Personal Transportation, CRC Press, 2009.
4. John German, Hybrid powered Vehicles, (2e), SAE International, Product Code: T-125, 2011.
5. Mehrdad Ehsani, Yimin Gao, Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Press, 2009.

AAE 4040: AUTOTRONICS [2 1 0 3]

Introduction to Automobile Electrical Systems, wiring harness, wiring diagram, Standards, and fundamentals of wiring. Earthing system of an automobile, types, and its advantages. Rectification process. Ignition system Starter motors. Development of the Ignition system. Engine Sensors - Manifold Absolute Pressure Sensor, Mass Air Flow Sensor, Crankshaft Positioning Sensor, Fuel Rail Pressure Sensor, Knock Sensor. Introduction to Switches, relays – types and functioning, Introduction to solid state switches, JFET and MOSFET. DC Motors, Brushless DC motors, Stepper Motors. Anti-lock braking system, Traction Control System, Electronic Suspension systems, Variable Damping via Different Oil Viscosity of Damper, Sensotronic Brake Control.

References:

1. Ribbens, Understanding Automotive Electronics, BH Publications, 2013.
2. Tom Denton, Automotive Electrical and electronics systems, Arnold London, 2007.
3. Bosch Automotive Electrics & Automotive Electronics, (5e), Springer View Meg, 2007.

AAE 4041: AUTOMOTIVE COMMUNICATION SYSTEM [2 1 0 3]

Communications Protocols-Communication Between Sensors And Systems (Power Train, Chassis Systems, Body Electronics, Instrument Clusters, Infotainment Systems). Inter-Vehicle Communications- Co-Operative Driving. Communication Fundamentals –Frequency, Bandwidth, Power Measurement, SNR, Transmission Rate Constraints. Radio Frequency Spectrum allocation—RADAR, Mesh Networking, Networking formation and Area of coverage. LIN—Goals and Applications. LIN Specification-Physical Layer, Master-Slave relationship, Datalink Layer. CAN Evolution, CAN Bus Signaling states, Physical Layer, Data Transmission. Wired Communication – Network Comparison, Two Tier Approach LIN Applications. CAN Applications- In vehicle operation, Infotainment Wireless Communication – Bluetooth Vehicle applications. Satellite Services –Satellite Radio, Vehicle Care. Vehicle Frequency Utilization –AM Radio, Bluetooth, FM Radio, GPS, Short range RADAR, Wireless LAN. Evolving Smart Vehicle – ECU, Wireless Networking, Forward RADAR, Side RADAR, GPS, Cellular transmission and Event Recorder.

References:

1. Gilbert Held, Inter and Intra Vehicle Communications, Auerbach Publications, 2008.
2. Tao Zhang, Luca Delgrossi, Vehicle Safety Communications Protocols, Security, and Privacy, Information Communication technology series, 2012.
3. Mohamed Kassab, Communication Technologies for Vehicles, Springer, 2015.
4. Florian Solzbacher, Jürgen Valldorf, Wolfgang Gessner, Advanced Microsystems for Automotive Applications, Springer Berlin

Heidelberg, 2003.

AAE 4042: BATTERY AND FUEL CELL TECHNOLOGY [2 1 0 3]

Introduction to Functional Safety Following ISO 26262, Description of Automotive Battery System Architecture. Classification and Application of Safety Measures for Automotive Battery Systems, Organizational and Technical Safety Measures, Application of Measures at Battery System Units, Considering non-E/E Measures in the Concept Phase. Specific Hazards of Electric Vehicles, Applicable Design Approach for Batteries, Automotive Battery Design, Modularity and Battery Components, Safety-Relevant Design Parameters, Structural Vehicle Design Process Including Batteries, Standard Approach and Requirements, Batteries in Crash Tests and Crash Simulation, Finite Elements Model of the Battery, Modelling of Mechanical Deformation, Modelling of Material and Joint Failure, Modelling of Electrical Contact and Leakage, Experimental , Thermal Runaway Experiment, , Gas Analysis, Empirical Models, Equivalent Circuit Modelling, Parametrization, Mechanistic Models, Charge Transfer, Ion Transport, Electron Transport, Porous Electrodes, Intercalation, Heat Generation, Cell Ageing, Large-Scale Modelling, Thermal Behaviour, Electrical Behaviour, Distributed-Micro-Structure Modelling, Mobility Demands and Primary Energy Resources, Internal Combustion Engines and Their Impact on Air Quality, Hydrogen Production, Hydrogen Distribution, Hydrogen Storage, Basic Concepts of Electrochemistry, Proton Exchange Membrane Fuel Cells, Sensitivity of PEM Stacks to Operating Conditions, Durability of PEM Fuel Cells, Design of Hydrogen Fuel Cell Systems for Road Vehicles, Hydrogen Fuel Cell Systems: Preliminary Remarks, Hydrogen Feeding System, Air Feeding Systems, Thermal Management System, Integrated Fuel Cell System: Efficiency, Dynamics, Costs.

References:

1. Pasquale Corbo, Fortunato Migliardini, Ottorino Veneri, Hydrogen Fuel Cells for Road Vehicles, Springer London Dordrecht Heidelberg New York, 2011.
2. Michael H. Westbrook, The Electric Car Development and future of battery, hybrid and fuel-cell cars, Co-published by The Institution of Engineering and Technology, London, United Kingdom, and Society of Automotive Engineers, Warrendale, USA, 2007.
3. Alexander Thaler, Daniel Watzenig, Automotive Battery Technology, Springer Cham Heidelberg New York Dordrecht London, 2009.
4. Mehrdad Ehsani, Yimin Gao, Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Press, 2009.
5. Amir Khajepourj M. Saber Fallahi Avesta Goodarzi, Electric and Hybrid Vehicles: Technologies, Modeling and Control - A Mechatronic Approach, Wiley, 2010.

AAE 4072: ACTUATION SYSTEMS [2 1 0 3]

The composition of Air, Gas Laws, Production of compressed air, air receivers, mains, dry and oil-free compressed air. Merits and demerits of the pneumatic system. Constructional details and working of filter, lubricator, pressure regulator, Linear actuator, rotary actuator. Classification of Valves, Graphical representations, Direction Control Valves, Nonreturn valves Pressure Control Valves, Flow control valves, Time Delay Valves, counter, General approach to control system design, symbols and drawings, travel step diagram, control modes. Design of manually operated, pilot operated control of single acting, double acting cylinder, multiple actuators; typical application circuits, computation of force, speed, valve sizing, selection of cylinders, P/E converter, optical, capacitance type, induction type, reflection nozzle, back pressure nozzle,

interruptible air jet, Relays, Solenoid valves, Latching Circuit, Logic operations, Timer, Counter, Development of circuits. Structure of PLC, Logic operations, Ladder Programming, Timers, Counters, Multiple Actuator Circuits, Application Area, Physical principles in hydraulics, hydraulic fluids, merits and demerits of hydraulic system, Hydraulic Power Pack, Pumps, Construction and working of various types of direction control, pressure control, and flow control valves, servo valve, proportional valve, and accumulator. Regeneration, meter in, meter out, bleed off, sequencing, counter balancing, pressure reducing and typical application circuits.

References:

1. Werner Deppert and Kurt Stoll, Pneumatic Control VOGEL Buchverlag Wurzburg, Germany, 1992.
2. Majumdar S. R, Pneumatic Systems Principles and Maintenance, Tata McGraw Hill, New Delhi, 2000.
3. Peter Croser, Frank Ebel, Pneumatics Basic Level TP 101 Festo Didactic GMBH & Co, Germany, 2002.
4. Prede G. and Scholz D., Electropneumatics Basic Level Festo Didactic GMBH & Co, Germany, 2002.
5. Hasebrink J. P. and Kobler R., Fundamentals of Pneumatic Control Engineering, Festo Didactic GMBH & Co, Germany, 2002.

AAE 4048: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING [2 1 0 3]

Introduction, basic models, Hebb's learning, Adaline, Perceptron, Multilayer feedforward network, Backpropagation, Different issues regarding the convergence of Multilayer Perceptron, Competitive learning, Types of learning, Self-Organizing Feature Maps, Adaptive Resonance Theory, Associative Memories, Applications. Genetic Algorithm (GA), different operators of GA, analysis of selection operations, Hypothesis of building blocks, Schema theorem and convergence of Genetic Algorithm, Simulated annealing and Stochastic models, Boltzmann Machine, Applications. Neural-Network-Based Fuzzy Systems, Genetic Algorithm for Neural Network Design and Learning, Machine learning, pattern recognition, image processing, text processing, natural language processing, graphics, cognition and computation, data mining, Introduction to Computer Vision: Edge detection, Point Correspondence and Stereopsis, Surface directions. fundamental blocks, case studies in various domains, the concept of shells, connectionist expert systems. Introduction to Natural Language Understanding: problems of ambiguity, ellipsis and polysemy, lexicalization and parsing. Intelligent Systems for Search and modelling, Automated Training Using an Intelligent System, Intelligent Systems for Control, Engine Estimator Design, Intelligent Control - A Planning Controller Search for Optimal Air Combat Tactics.

Reference:

1. Rajsekharan S., Vijayalaxmi Pai, Neural Networks, Fuzzy logic and Genetic Algorithms, Synthesis and applications. PHI Learning Pvt. Ltd. 2003.
2. Russell, S. and Norvig, P., Artificial Intelligence: A Modern Approach, Prentice Hall, New Jersey, 1995.
3. Ethem Alpaydin, Introduction to Machine Learning, (3e), MIT Press 2014.
4. Stephen Marsland, Machine Learning: An Algorithmic Perspective. (2e) CRC press 2014.
5. Christopher M. Bishop, Pattern Recognition and Machine Learning. Springer-Verlag 2006.
6. Krishnakumar, K., Intelligent Control for Aerospace Systems, Global Aerospace Technology, World Market Research Center, 2000.

AAE 4073: AUTOMOTIVE EMBEDDED SYSTEMS [2 1 0 3]

Automotive Vehicle Technology, Overview of Vehicle Categories, Various Vehicle Sub Systems like Chassis, Body, Driveline, Engine, Fuel, Emission, Brakes, Suspension, ,Emission, Brakes, Suspension, Doors, Safety & Security , Comfort & Multimedia, Communication & Lighting, Future Trends in Automotive Embedded Systems : Drive by Wire, Autopilot, Robotics, Automotive Sensors and Transducers: Typical Sensors Specifications & Microcontroller Interface Considerations, Sensor Calibration, Concept to Market: Actuators, Sensors ,Semiconductor Components, Devices (MOSFET, JFET,SCR,BJT), Integrated Circuits (ICs), SMD Components and Packages , PCBs etc., Electric Motors & Driving Techniques: Stepper Motors , DC Motor , BLDC, PM Motor etc. Printed Circuit Board Concepts for Thermal, Reliability, EMI/EMC, Noise & Enclosure Selection. The need for Protocol, Intra processor Communication Protocols: I2C & I2S, SPI, RS485 MODBUS & USB, Introduction to Automotive Protocols: LIN, CAN, KWP2000, J1850 & J1939 Flex Ray & MOST Design, Test, Calibration and Diagnostics tools for networking of electronic systems like ECU Software and Testing Tools, ECU Calibration Tools, Diagnostic and Bus Monitoring Tools, Vehicle Network Simulation. Advanced Trends in Automotive Electronics: AUTOSAR Architecture, Infotainment & Multimedia, Microcontroller Architecture : MSP430 , HCS12 , 32 Bit ARM LPC2148 & Cortex M3 Architecture .Automotive Grade Microcontrollers like ATmega164P , AT32UC3C2512C , Safety Critical Microcontrollers like Hercules TMS470M ARM Cortex-M3 Series, Microcontrollers with Built-in CAN Interface , Introduction to Software Development Tools : Keil MDK, Win ARM, TI Code Composer Studio And Atmel AVR Studio 6.0 Version Control Systems: Tortoise SVN, Coding Standards and Guidelines: MISHRA C & AuroSar. The Validation and Verification (V & V) Process, Introduction to NI Lab VIEW for Automotive V & V. Test Categories like Functional Test, Black Box Test EMI/ EMC Tests as per IEC 1000-3, IEC 1000-4 & IEC 1000-5 standard, Environmental Test, Vibration Tests, Protection against Dust, Water Ingress and IP Standards Vehicle Diagnostic Interface OBD - II, Documentation Techniques & Templates

References:

1. Nicolas Navet & Francoise Simonot-Lion, Automotive Embedded Systems Handbook, CRC Press; (1e), 2009.
2. Eric Armengaud, Allan Tengg et al, Automotive Embedded Systems, Springer, 2011.
3. Wilfried Voss, A Comprehensible Guide to Controller Area Network, (2e), Copperhill Media Corporation, 2005.

AAE 4074: AUTOMOTIVE POLLUTION AND CONTROL [2 1 0 3]

Introduction - Historical background, Regulatory test procedures, Analysis of pollutants, Pollution from Spark Ignition engines, Pollution from Compression Ignition engines, Fuels for spark ignition and compression ignition engines, Engine Variants- Lean Burn engines, Stratified charge engines, Direct Injection in Gasoline engines, Instrumentation for pollution measurements- Non Destructive Infrared analyzers, thermal conductivity and flame ionization detectors, analysers for NOx, gas chromatograph, Alternative Fuels- Hydrogen, Natural gas, Liquefied petroleum gas, vegetable oil and biodiesel, Biomass Energy, Direct Energy conversion methods-solar cells, thermos-ionic converters.

References:

1. Ganesan V., Internal Combustion Engines, Tata Mcgraw-hill Education, New Delhi, 2012.
2. Mathur M. L. and Sharma R. P., Internal Combustion Engines, Dhanpat Rai Publications, New Delhi, 2011.
3. Colin R Ferguson and Allan T Kirkpatric, Internal Combustion Engines, Wiley India Ltd, New Delhi, 2004.
4. Willard W Pulkrabek, Engineering Fundamentals of Internal

Combustion Engines, PHI Learning Pvt Ltd, New Delhi, 2004.

5. Sukatme S. P., Solar Energy Principles of Thermal Collection and Storage, Tata Mc Graw Hill Education, New Delhi, 2005.

AAE 4049: BIO-INSPIRED COMPUTATIONAL TECHNIQUES [2 1 0 3]

Bio-inspired Computation Algorithms ,Ant Colony Optimization ,Biological Inspiration ,Principle of Ant Colony Optimization ,Ant System and Its Extensions, Particle Swarm Optimization, Biological Inspiration ,Principle of Particle Swarm Optimization ,Parameters and Population Topology, Artificial Bee Colony ,Biological Inspiration, Principle of Artificial Bee Colony, Algorithmic Structure of Artificial Bee Colony, Differential Evolution , Biological Inspiration, Principle of Differential Evolution , Control Parameters of Differential Evolution ,Glowworm Swarm Optimization, Bacteria Foraging Optimization ,Bat-Inspired Algorithm, Biological Vision-Based Surveillance and Navigation, ABC Optimized Edge Potential Function Approach to Target Identification, The Principle of Edge Potential Function ABC Optimized EPF Approach to Target Identification , Chaotic Quantum-Behaved PSO Based on Lateral Inhibition for Image Matching, The Quantum-Behaved PSO Algorithm, Lateral Inhibition Mechanism , Chaotic Quantum-Behaved PSO Based on Lateral Inhibition ., Implementation of Autonomous Visual Tracking and Landing for Low-Cost Quadrotor, The Quadrotor and Carrier Test Computer Vision Algorithm , Control Architecture for Tracking and Landing .

References:

1. Haibin Duan, Pei Li, Bio-inspired Computation in Unmanned Aerial Vehicles, Springer, 2014.
2. Hagan, Demuth, Beale- Thomas Learning, Neural Network Design, Vikas Publishing House.
3. Jacek M. Zurada, Introduction to Artificial Neural Systems, Jaico Publishing House, 1997.
4. Xin-She Yang and João Paulo Papa, Bio-Inspired Computation and Applications in Image Processing, Elsevier, 2013.

AAE 4050: COMPOSITE STRUCTURES [2 1 0 3]

Classification characterization composites, Mechanical Behavior of composite materials, Basic terminologies, Review of Basic Equations of Mechanics and Materials and Linear Elasticity, Stress-Strain Relations for a unidirectional and orthotropic lamina, Effective Moduli of a continuous fibre reinforced, lamina - Models based on mechanics of materials, the theory of elasticity. Numerical Examples. Stress-displacement relationship, Stress-strain relationship, Laminate stiffness, Determination of lamina stresses and strains. Special cases of laminate stiffness. Inter-laminar Stresses. Numerical Examples. Failure of Continuous Fibre-reinforced orthotropic Lamina. Maximum stress/strain criteria, Tsai-Hill and Tsai-Wu criterion, Hygrothermal effects on material properties on the response of composites. Numerical Examples.

References:

1. Gibson R. F., Principles of Composite Material, (4e), Mechanics, CRC Press, 2016.
2. Kollar L. P., George S Springer, Mechanics of Composite Structures, Cambridge University Press, 2009.
3. Agarwal B. D., Broutman L. J. and Chandrashekhara K., Analysis and Performance of Fiber Composites, (3e), John Wiley & Sons, 2006.
4. R. M. Jones, Mechanics of Composite Materials, (2e), Taylor & Francis, 2005.
5. Madhujit Mukhopadhyay, Mechanics of Composite Materials and Structures, Orient Longman, 2004.

AAE 4075: COMPUTATIONAL FLUID DYNAMICS [2 1 0 3]

Derivation of governing equations of fluid dynamics and discussion on a characteristic of the governing equations, the initial and boundary conditions. The mathematical behaviour of different classes of partial differential equations. Discretization of governing equations using Finite Difference and Control Volume approach. The basic solution techniques for steady-state and transient equations. Solutions of Diffusion Problems. Numerical methods for steady 1-D convective flow with diffusion. The need for a staggered grid. Discussion on SIMPLE, SIMPLER and PISO algorithms. Implementation of Boundary Conditions in CFD.

References:

1. John D Anderson Jr, Computational Fluid Dynamics- The Basics with Applications, International Edition. McGraw Hill, New York, 1995.
2. Suhas V Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere/ McGraw Hill. New York, 1980.
3. Versteeg H. K. and Malalasekera W., An Introduction to Computational Fluid Dynamics - The Finite Volume Method, Longman Scientific & Technical. England, 1995.
4. Muralidhar K. and Sundararajan T., Computational Fluid Flow and Heat Transfer, Narosa Publishing House, NewDelhi, 2003.
5. Anderson D. A, Tannehill J. C, and Pletcher, R. H, Computational Fluid Mechanics and Heat Transfer, Taylor and Francis Group. New York, 1997.

AAE 4051: COMPUTER INTEGRATED MANUFACTURING [2 1 0 3]

Historical background of Manufacturing, Definition of N.C. Machine, Classification, Design consideration of N.C. Machine tools, general construction requirements, Methods of improving machine accuracy and productivity, Control loops of NC systems – Control loop of a point to point systems, Control loop of contouring systems. Co-ordinate systems, point to point and contour programming, manual method (word address format only), Computer Numerical Control, Direct Numerical Control, Adaptive Control Machining System, Programmable Logic Controller, Introduction to Robotics, Robot anatomy physical configurations, Manipulator Kinematics, Technical features, robotic applications. Automated Inspection and Testing: Principle and Methods, Part classification and coding, production flow analysis, machine cell design, benefits of group technology, Computer Integrated Manufacturing System, Types of Manufacturing System, Material Handling System, Flexible Manufacturing System, Computer control in CIM, Computer-aided Process planning, Computer integrated planning systems. Material requirement planning. Capacity planning, shop floor control, factory data collection systems, automatic identification systems – Barcode technology, automated data collection systems.

References:

1. Mikel P Groover, Automation, Production Systems and computer Integrated manufacturing, PHI, New Delhi, 2008.
2. Yoram Koren, Computer Control of Manufacturing Systems and Computer Integrated Manufacturing, PHI, New Delhi, 2006.
3. Yoram Koren, Joseph Ben Uri, Numerical Control of Machine Tools, Khanna Publishers, New Delhi, 2005.
4. Mikell P Groover and Emory W Zimmers, Computer-aided design and manufacturing, PHI, New Delhi, 2008.

AAE 4076: CRASHWORTHINESS AND SAFETY [2 1 0 3]

Motor Vehicle Safety, The Automobile Structure, Materials, Crashworthiness, Crashworthiness Goals, Achieving Crashworthiness, Crashworthiness Tests, Crashworthiness Models Requirements. Current Design Practice, Comparison Between LMS and FE-Based Crashworthiness Processes, Lumped Mass-Spring Models, Limitations of LMS Models, Crash/Crush Design Techniques for Front

Structures, Principles of Designing for Crash Energy Management, Review of Analytical Design Tools for Crash Energy Management, Analytical Design Tools, Axial Collapse, Folding Mechanism of Box Column During Axial Collapse, Bending Collapse Mathematical Models, Moment-rotation characteristics of thin-walled beam, Structural Joints, Design of Substructures, Axial crash mode. Vehicle-to-Vehicle Frontal Collisions, Preliminary Relationships in Head-on Frontal Collision. Overview of Explicit FE Technology, Explicit Integration, Shell Element, Plasticity, Contact Treatment, Limitations of Current Technology, Applications. Basic Laws and Concepts of Motion, Basic Principles of Postulates, Particle Under Given Forces, Interactions, Two Additional Postulates, Idealizations, Application of Concepts to Vehicle/Occupant Analysis, Vehicle Response, Occupant Response, Axioms for Good Occupant Restraint Performance and Design, Compatibility Between Restraint System and Vehicle Front Structure, Supplemental Airbag Restraint System (SARS), Restrained Occupant Models (Analytical Approach). Human Body Modeling, Lumped Mass Models, Multi-Body Models, Finite Element Models, Multi-Body Models Versus Finite Element Models, MADYMO Set-Up, MADYMO Multi-Body Algorithm. Introduction, Injury Mechanisms, Head Injury Mechanisms, Neck Injury Mechanisms, Compression Injuries, Tension-Flexion Injuries, Compression-Extension Injuries, Thoracic Injury Mechanisms, Abdominal Injury Mechanisms, Pelvic Injury Mechanisms

References:

1. Paul Du Bois Clifford C. Chou Bahig B. Fileta Tawfik B. Khalil Albert I. King Hikmat F. Mahmood Harold J. Mertz Jac Wismans, Vehicle Crashworthiness and Occupant Protection, Automotive Applications Committee American Iron and Steel Institute Southfield, Michigan, 2004.
2. CAE Methods for Vehicle Crashworthiness and Occupant Safety, and Safety-critical Systems, SAE special publication: Society of Automotive Engineers, 2004.
3. Narayan Yoganandan, Alan M. Nahum, John W. Melvin, Accidental Injury: Biomechanics and Prevention, The Medical College of Wisconsin Inc, 2015.
4. Jorge A. C. Ambrosio, Crashworthiness: Energy Management and Occupant Protection, Springer-Verlag Wein publication Newyork, 2001.

AAE 4077: ERGONOMICS IN AUTOMOTIVE DESIGN [2 1 0 3]

Ergonomics in vehicle design, ergonomics approach, problem solving methodologies, importance of ergonomics, Use of anthropometry in designing vehicles, biomechanics consideration in seat design, seat design consideration related to driver accommodation, Vehicle packaging, package layout, driver package development procedure, Controls and display interfaces, Introduction to filed view, types of filed view, forward field of view and evaluation, mirror design issue, methods of measuring field of view, other visibility issues, Introduction, problem during entry and exit, vehicle feature and dimensions related to entry and exit, method of evaluating entry and exit.

References:

1. Vivek D Bhise, Ergonomics in automotive design process, CRC Press Publications, 2012.
2. Nikolaos Gkikas, Automotive ergonomics – Driver vehicle interaction, CRC Press Publication, 2013.
3. Mark R Lehto, James R Buck, Introduction to human factors and ergonomics for engineers, Taylor and Francis Group publication, 2008.
4. Gavriel Salvendy (Editor), Handbook of Human Factors and Ergonomics (4e), John Wiley and Sons, 2012.

AAE 4052: EXPERIMENTAL STRESS ANALYSIS [2 1 0 3]

Extensometers and Displacement Sensors, Advantages and disadvantages, electrical resistance strain gauges, Types and their uses, Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators, Rosette analysis, stress gauges, load cells, Data acquisition, six component balance, Two dimensional photo elasticity, Photo elastic materials, Concept of light – photoelastic effects, stress optic law, Transmission photoelasticity, Jones calculus, plane and circular polariscopes, Interpretation of fringe pattern, Calibration of photoelastic materials, Compensation and separation techniques, Introduction to three dimensional photo elasticity. The relation between stresses in coating and specimen, use of failure theories in the brittle coating, Moire method of strain analysis.

References:

1. Dally, J. W. and Riley, W. F., Experimental Stress Analysis, McGraw Hill Inc., New York 1998.
2. Srinath, L. S., Raghava, M. R., Lingaiah K., Garagesha G., Pant B. and Ramachandra K., Experimental Stress Analysis, Tata McGraw Hill, New Delhi, 1984.
3. Sadhu Singh, Experimental Stress Analysis, Khanna Publishers, New Delhi, 1996.
4. Pollock A. A., Acoustic Emission in Acoustics and Vibration Progress, Stephens R.W.B., Chapman and Hall, 1993.
5. Ramesh, K., Digital Photoelasticity, Springer, New York, 2000

AAE 4053: EXPLORATION AND MAPPING USING AUTONOMOUS SYSTEMS [2 1 0 3]

Introduction, Basic Techniques Mobile Robot Localization Using Particle Filters. Grid Maps. Decision-Theoretic Exploration Using Coverage Maps, Definition of Coverage Maps, Updating Coverage Maps upon Sensory Input. Choosing the Closest Target Location, Exploration Using the Information Gain. Mapping with Noisy Sensors. Comparing, the Viewpoint Selection Strategies, Coordinating a Team of Robots during Exploration, Cost of Reaching a Target Location. Computing Utilities of Frontier Cells, Target Point Selection, Coordination with Limited Communication Range, Collaborative Mapping with Teams of Mobile Robots. ,Comparison between Uncoordinated and, Coordinated Exploration ,Exploration with Limited Communication, Comparisons to Other Coordination Techniques ,Semantic Place Labeling,Estimating the Label of a Goal Location ,Using Semantic Place Information for Efficient, Multi-Robot Exploration ,Mapping and Exploration under Pose Uncertainty, Using Laser Range Data to Compute an Improved, Proposal Distribution . , Selective Resampling. , Actively Closing Loops During Exploration. Detecting Opportunities to Close Loops. , Representing Actions under Pose Uncertainty, Active Loop-Closing vs. Frontier-Based, Exploration. Mapping and Localization in Non-Static, Environments, Learning Maps of Low-Dynamic Environments, Map Segmentation, Learning Configurations of the Environment. Map Clustering, Application in an Office Environment., Localizing the Robot and Estimating the State of, the Environment, Global Localization

References:

1. Robotic Mapping and Exploration, Cyrill Stachniss, Springer, 2009.
2. Bellman R. E., Dynamic Programming. Princeton University Press, Princeton 1957.

AAE 4078: FARM MACHINERY AND EARTH MOVING EQUIPMENT [2 1 0 3]

Introduction, overview of engine components, Lubrication, Cooling system, Supercharger and Turbo charger, Types of transmission system, construction of hydro shift transmission, final drive, power take off

shafts, Power steering system, integral and linkage type, planetary steering system, types of brakes, Classification of earth moving equipment's, constructional details of Dozers, Loaders, Shovels, Excavators, Rippers, Trenchers, Dredgers, Drag Line, Clamshell, Scrapers, Motor Graders, Rollers, Compactors, Material handling Systems, Types of tractors, tractor attachments, tillage equipment's, under carriage unit of earth mover, Suspension system, Tyres, maintenance and safety of earth movers.

References:

1. Erich J. schulz, Diesel equipment- volume I and II, 1981.
2. Sharma S. C., Construction Equipment and Management, Khanna Publishers, 2002.
3. Rodichev and Rodicheva G., Tractor and Automobiles, MIR Publishers, 1987.
4. Kolchin. A., and Demidov V., Design of Automotive engines for tractor, MIR Publishers, 1972.
5. Harris Pearson Smith, Farm Machinery and Equipment, Tata McGraw Hill Publishers, 1977.

AAE 4054: FRACTURE MECHANICS [2 1 0 3]

Fracture Mechanics Principles: Mechanisms of Fracture, the Griffith's criterion, Stress intensity approach. Stress Analysis for Members with Cracks: Linear elastic fracture mechanics, Crack tip stress and deformations; Relation between stress intensity factor and fracture toughness, Plane stress and plane strain concepts. The Dugdale approach. Elastic-Plastic Fracture Mechanics: Elasto-plastic factor criteria, crack resistance curve, Crack opening displacement. Importance of R-curve in fracture mechanics, Experimental determination of I-integral. Dynamic and Crack Arrest: the dynamic stress intensity and elastic energy release rate, crack branching, the principles of crack arrest, and the dynamic fracture toughness. Fatigue and Fatigue Crack Growth Rate: Fatigue loading, Various stages of crack propagation, the load spectrum, approximation of the stress spectrum, the crack growth integration, fatigue crack growth laws. Fracture Resistance of Materials: Fracture criteria, fatigue cracking criteria, the effect of alloying and second phase particles.

References:

1. Karen Helen, Introduction to Fracture Mechanics, McGraw Hill Pub, 2000.
2. Jayatilake, Fracture of Engineering Brittle Materials Applied Science, London, 2001.
3. Anderson T. L., Fracture Mechanics Application, CRC press, 1998.
4. David Broek, Elementary Engineering Fracture of Mechanics, Martinus Nijhoff, London, 1999.

AAE 4055: GLOBAL POSITIONING SYSTEM TECHNOLOGY [2 1 0 3]

Introduction and Heritage of NAVSTAR, The Global Positioning System, Overview of GPS Operation And Design, Coordinate and time systems, Definition of global and local coordinate systems, Relationship between satellite and conventional geodetic systems, Satellite orbital motions, Different Satellite Constellation And Geometric Dilution of Precision, Indian satellite program-GAGAN/IRNSS constellation and Signal structure, GPS Signal Structure And Theoretical GPS Navigation, GPS Satellite And Payload , Fundamentals of Signal Tracking Theory ,GPS Receivers, GPS Navigation Algorithms & GPS observables, estimation procedure, GPS Operational Control Segment, GPS Error Analysis, Ionospheric Effects on GPS Tropospheric Effects on GPS, Multipath Effects , Foliage Attenuation For Land Mobile/aerospace Users, Ephemeris and Clock Navigation Message Accuracy , Selective Availability , Introduction to Relativistic Effects on The Global Positioning System, Interference Effects and Mitigation Techniques , methods of GPS processing data, Applications and examples of GPS data analysis along with other space geodetic data. Satellite based augmentation system and application, Kalman Filter in GPS, Front End Receiver.

Reference:

1. Hofmann-Wellenhof, Lichtenegger B. H., and Collins J., GPS Theory and Practice, Springer, ISBN: 9780387824772, 1994.
2. Parkinson B. W., Spilker J., et al., Global Positioning System: Theory and Applications. Vol. 1. American Institute of Aeronautics & Ast, ISBN: 9781563471063, 1996.
3. Parkinson, B. W., Spilker J., et al., Global Positioning System: Theory and Applications. Vol. 2. American Institute of Aeronautics & Ast, ISBN: 9781563471070, 1996.
4. Pelton, Joseph N., Madry, Scott, Camacho-Lara, Handbook of Satellite Applications, Sergio (Eds.), 2013.
5. John W Betz, Wiley Online Library, Engineering Satellite-Based Navigation and Timing: Global Navigation Satellite Systems, Signals and Receivers, 2015.

AAE 4079: GREEN ENERGY TECHNOLOGY [2 1 0 3]

Energy, environment, pollution control and sustainable development, Energy sources Introduction to nexus between Energy, Overview of global/ India's energy scenario, Renewable energy resources & systems, sources of renewable energy, solar radiation, and measurement of solar radiation: Instruments, models and methods for estimating solar radiation, solar photovoltaic energy conversion, structuring and assembly, bio energy and conversion systems, Green nanotechnology, Nanoparticles preparation techniques, waste to energy conversion and management, waste management hierarchy, waste minimization and recycling of MSW; Life Cycle Analysis (LCA), Material Recovery Facilities (MRF), recycling processes of solid waste.

Reference:

1. Sukhatme S. and Nayak J., Solar Energy: Principles of Thermal Collection and Storage, (3e), Tata McGraw Hill, 2008.
2. Gopal Nath Tiwari, Fundamentals of Photovoltaic Modules & Their Applications, ISBN: 9781849730204, Publisher: Royal Society of Chemistry, 2010.
3. Jazmin Seijas, Green Management and Green Technologies: Exploring the Causal Relationship, Nogarida, 2008.
4. Richard Maltzman And David Shiden, Green Project Management, ISBN: 9781853835988, Environmental Risk Management By Paul Pritchard, Earth Scan Publications, 2001.
5. Geoffrey B. Smith, Claes-Goran S. Granqvist, Green Nanotechnology: Solutions for Sustainability and Energy in the Built Environment, CRC Press, 2010.

AAE 4056: INDUSTRIAL AUTOMATION [2 1 0 3]

Introduction: Principles and strategies of automation, basic elements, transfer lines. Material handling and identification technologies: Overview, Principles and Design Consideration, Automatic Identification Methods. Automated Manufacturing Systems: Components, Classification and GT and Cellular Manufacturing, FMS. Quality Control Systems: SPC Tools, Inspection Principles. Control Technologies in Automation: Industrial Control Systems Continuous Versus Discrete Control, Computer Process. Computer-Based Industrial Control: Introduction & Automatic Process Control, Building Blocks of Automation Systems Distributed Control System. Modelling and Simulation for Plant Automation need for system Modelling Modern Tools & Future Perspective.

References:

1. Mikell P. Groover, Automation, Production System and Computer Integrated Manufacturing, (4e), Pearson Higher Education, 2015.
2. Krishna Kant, Computer Based Industrial Control, (2e), EEE-PHI, 2010.
3. Viswanandham, Performance Modeling of Automated Manufacturing Systems, (1e), PHI, 2009.

AAE 4057: LIGHTWEIGHT MATERIALS [2 1 0 3]

Introduction and use of lightweight materials, Aluminium alloys, magnesium alloys, beryllium and titanium alloys: Application, designation and heat treatment. Introduction to composite materials, types of material and manufacturing methods. FRP constituents: fibres and resins. Micromechanics of a lamina. Analysis of an individual ply. Macro-mechanics of a laminate; stiffness, strength and analysis techniques. Stress distribution around holes in laminates. Test methods; determination of elastic constants, static strengths, fibre volume fractions and void content. Metal matrix composites. Ceramic matrix composites. Selection guidelines for lightweight materials.

References:

1. Campbell F. C., Introduction to lightweight Materials, ASM International, 2012.
2. Jones R. M., Mechanics of Composite Materials (2e), Taylor and Francis, 2017.
3. Kaw A. K., Mechanics of Composite Materials (2e), Taylor and Francis, 2006.

AAE 4060: OPERATIONS AND SUPPLY CHAIN MANAGEMENT [2 1 0 3]

Forecasting, Need for forecasting, Quantitative methods, Facility layout and location, Qualitative aspects, Quantitative models for layout decisions. The product, process fixed position, group layout. Location decisions-quantitative models, Capacity and aggregate planning, Capacity measurement, Long-term and short term strategies, Aggregate planning, Inventory management, Various costs in inventory management and need, Deterministic models and discounts., Probabilistic inventory management, Scheduling models and applications, Scheduling in MRP system, Sequencing rules and applications, Batch production sequencing and scheduling, Introduction to supply chain, complexity, key issues, Supply chain strategy and performance measures, Centralized vs. decentralized systems, Value of information and supply chain integration, Bullwhip effect, Push-based, pull based systems, Outsourcing : Make or buy decisions, Transportation decision, Drivers of the decision., Network design decisions, Cross-docking, transshipment, Distribution and logistics in supply chains, Direct shipment/intermediate storage policies, Vehicle routing models, Third-party logistics, Information Technology in supply chain, Enabling supply chain through IT., ERP vendor platforms, Service oriented architecture (SOA).

References:

1. David A. Collier and James R. Evans, Operations Management, Cengage Learning, 2016.
2. Jay Heizer and Barry Render, Operations Management, Pearson, 2013.
3. Ray R. Venkataraman and Jeffrey K. Pinto, Operations Management: Managing Global Supply Chains, Sage Publisher, 2017.
4. Janat Shah, Supply Chain Management, Prentice Hall, 2013.
5. Sunil Chopra and Peter Meindl, Supply Chain Management: Strategy, Planning, and Operation, Pearson Education, 2018.

AAE 4062: OPTIMIZATION TECHNIQUES [2 1 0 3]

Introduction to optimal design. Elements of an optimal design problem. Formulation of optimal problem. Local and global optima. Single variable optimization: region elimination methods, bracketing methods and gradient-based methods. Multivariable optimization without constraints: Direct search methods and gradient-based methods. Multivariable optimization with constraints: Sequential Unconstrained Minimization

Techniques Constraint Scaling, Augmented Lagrange Method (ALM) for Equality Constraints, ALM for Inequality Constraints and Generalized ALM. Heuristic search methods: Tabu search, simulated annealing, genetic algorithms. Multi-objective optimization and Pareto optimality. Sensitivity, trade-off analysis, goal programming. Multidisciplinary design optimization and methods.

References:

1. Rao S. S., Engineering optimization, New Age Int., 2013.
2. Kalyanmoi Deb, Optimisation for engineering Design, Prentice Hall India, 2004.
3. Ashok Belegundu and Chandrapratala T., Optimisation concepts and applications in engineering, Cambridge University Press, 2011.
4. Arora J. S., Optimum Design, Academic press, 2012.
5. Kalyanmoi Deb, Multi-objective optimization using evolutionary algorithms, John Wiley and sons, 2002.
6. Jaroslaw S. S., Moris A., Tooren M. V., Multidisciplinary design optimization supported by knowledge based engineering, John Wiley and sons, 2015.

AAE 4064: PRODUCT DESIGN AND DEVELOPMENT [2 1 0 3]

Classification/ Specifications of Products. Product life cycle. Product mix. Introduction to product design. Modern product development process. Innovative thinking, TRIZ (TIPS), Morphology of design. Conceptual Design: Generation, selection & embodiment of concept. Product architecture. Industrial design: process, need. Robust Design: Taguchi Designs & DOE. Design for Mfg & Assembly: Methods of designing for Mfg & Assy. Designs for Environment. Product Costing. Legal factors and social issues. Engg ethics and issues of society related to the design of products. Value Engineering / Value Analysis. : Definition. Methodology. Case studies. Economic analysis: Qualitative & Quantitative. Ergonomics / Aesthetics: Gross human autonomy. Anthropometry. Man-Machine interaction.

References:

1. Karl T Ulrich, Steven D Eppinger, Product Design & Development, Tata McGraw-Hill New Delhi, 2004.
2. David G Ullman, The Mechanical Design Process, McGrawhill Inc Singapore 1992.
3. Rozenberg N. J. M., Ekels J. R, Product Design Fundamentals and Methods, John Willey & Sons, 1995.
4. Kevin Otto & Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson Education New Delhi, 2004.
5. Hollins B. & Pugh S., Successful Product Design, Butter worths London, 1990.
6. Baldwin E. N. & Neibel B. W., Designing for Production, Edwin Homewood Illinois, 1963.

AAE 4066: ROBUST CONTROL [2 1 0 3]

Introduction to Robust Control, Control system specifications for aerospace vehicles, robustness issues: robust stability and robust performance, describing functions. Robust Control of Linear & Nonlinear Systems:-Introduction, Matched Uncertainty, Unmatched Uncertainty Uncertainty in the Input Matrix, Problems, Kharitonov Approach:-Introduction, Preliminary Theorems, Kharitonov theorem, Control Design Using Kharitonov Theorem, Problems, Eigen structure assignment techniques, Eigenstructure assignment, output feedback, Observer design, Controller Synthesis by Robust Eigen structure Assignment, LQR, LQG/LTR, H₂ and H_∞ control optimization/H_∞ Optimal Control, Robustness Analysis, Nonlinear H_∞ Control, Introduction to neuro-fuzzy control, examples of state, output feedback

and tracking control systems for aerospace vehicles, Robust Adaptive control.

Reference:

1. Feng Lin., Robust Control Design: An Optimal Control Approach, John Wiley & Sons, Inc. ISBN: 978-0-470-03191-9, 2007.
2. Bhattacharya, Apellat, Keel, Robust Control-The Parametric Approach, Prentice Hall PTR. 2000.
3. John Doyle and Keith Glover, Robust and Optimal Control, Kemin Zou, Prentice Hall, 1995.
4. Zhou, Kemin and Doyle C., John, Essentials of Robust Control, Prentice Hall, 1999.
5. Morari, Manfred and Zafiriou, Evangelhos, Robust Process Control, Prentice Hall, 1989.

AAE 4069: STATISTICAL QUALITY CONTROL & RELIABILITY [2 1 0 3]

Fundamentals of quality and quality control. A measure of central tendencies. Probability Distributions. Tolerance allocation. Control chart for variables and attributes. Process capability analysis and process capability index. Acceptance sampling. Operating characteristic curves. Dodge romig and MIL-STD acceptance sampling tables. The concept of reliability, Reliability systems, maintainability.

References:

1. Montgomery D. C., Introduction to Statistical Quality Control, (2e), John Wiley & Sons, New York 2005.
2. Amitav Mitra, Fundamentals of quality control and improvement (3e) Wiley 2008.
3. Grant E.L., Statistical Quality Control, (6e), McGraw Hill Publications, New York 1988.
4. Duncan, Quality Control and Industrial statistics, Irwin Press, New York 1960.
5. Juran J.M., Quality Planning and Analysis, (2e) McGraw Hill Publications, Delhi 1984.
6. Bertrand L. Hansen, Quality Control-theory and applications, Hall India, Delhi 1987.

AAE 4070: SURFACE ENGINEERING AND COATING TECHNOLOGY [2 1 0 3]

Introduction, Surface-dependent engineering properties, common surface-initiated engineering failures; mechanism of surface degradation; mechanisms of wear, abrasive, adhesive wear, contact fatigue – fretting corrosion; importance and necessity of surface engineering; classification and scope of surface engineering in metals, ceramics, polymers and composites, tailoring of surfaces of advanced materials. Surface Preparation methods such as Chemical, Electrochemical, Mechanical: Sand Blasting, Shot peening, Shot blasting, Hydro-blasting, Vapor Phase Degreasing etc., Coatings: Classification, Properties and applications of Various Coatings. Surface protection and surface modification techniques: principles, methods, and technology; Surface modification by use of directed energy beams, Plasma, Sputtering & Ion Implantation. Surface modification by Friction stir processing, Surface composites. Chemical Conversion Coating-Chromating, Anodizing, Thermochemical processes: Metallic coating-Hot Dipping, Galvanizing, Electrolytic and Electroless plating: Methodology used, mechanisms, important reactions involved, Process parameters and applications. Diffusion Coatings- coating properties and applications, Principles of cementation – cladding – Diffusion coating of Al , Si, Cr and B – structure, properties and application of diffusion coatings – Carburizing, Carbonitriding, Siliconizing, Chromizing, Aluminizing, Boronizing, Boronitriding: Thin film Coating: Coating from Vapour Phase- PVD, and CVD: Diamond Like Carbon (DLC) coating, Nano crystalline diamond coating Thermal spray coatings- Processes,

Surface Preparation, Finishing Treatment, Coating Structures and Properties, Applications; selection of coatings ,testing wear resistance practical diagnosis of wear, non-destructive testing, scratch resistance testing, ASTM and other standards for the testing of engineering coating Characterization of Coatings: Physical Characterization, Assessment of Adhesion of Coating, Surface microscopy & topography by scanning probe microscopy, Spectroscopic analysis of modified surfaces Case studies: Case studies based on coatings and surface modification of important engineering components.

References:

1. ASM Handbook Volume 5: Surface Engineering, American society of metals, 1994.
2. Ian Hutchings, Philip Shipway, Tribology: Friction and Wear of Engineering Materials, Butterworth-Heinemann, 2017.
3. Davis J. R., Surface Engineering for Corrosion and Wear Resistance, CRC Press, 2001.
4. Ohring M., The Materials Science of Thin Films, Academic Press Inc, 2005.
5. Gamburg, Yuly D., Zangari, Giovanni, Theory and Practice of Metal Electrodeposition, Springer, 2011.
6. Budinski K. G., Surface Engineering for Wear Resistances, Prentice Hall, Englewood Cliffs, 1988.
7. William E. Bryson, Heat Treatment, Selection, and Application of Tool Steels, Hanser Publications, 2005.

AAE 4080: TWO AND THREE-WHEELED VEHICLES [2 1 0 3]

Introduction, an overview of two-wheelers, Classification of two-wheeled vehicles, identification of essential systems, layouts of two-wheelers, Classification of engines used in two-wheelers. Engine anatomy, constructional details, induction methods, scavenging methods, fuel supply systems, constant choke and constant venturi carburetors. Lubrication systems, Cooling systems., Ignition systems, circuit diagrams for lighting, horn, starter motor, Two-wheeler chassis, steering systems, Front and rear suspension systems, Braking systems Transmission system layouts for scooters, motorcycles, mopeds, three-wheeled vehicles and details of subsystems. Wheels and tyres, Classification of three-wheeled vehicles, CNG fuel system, LPG systems. Electric drives for two-wheeled vehicles. Safety aspects in two-wheeled vehicles, emission standards followed for two and three wheelers.

References:

1. Dhruv U Panchal, Two and Three wheeler technology, (1e), PHI Publications, New Delhi, 2015.
2. Ramalingam K. K., Two wheelers, sci-tech publications(India) Pvt Ltd, Chennai, 2014 York 1960.
3. Narang G. B. S., Automobile Engineering, (2e), Khanna publishers, 2014.

OPEN ELECTIVE

AAE 4301: AUTOMOTIVE POLLUTION AND CONTROL [2 1 0 3]

Introduction- Historical background, Regulatory test procedures, Analysis of pollutants, Pollution from Spark Ignition engines, Pollution from Compression Ignition engines, Fuels for spark ignition and compression ignition engines, Engine Variants- Lean Burn engines, Stratified charge engines, Direct Injection in Gasoline engines, Instrumentation for pollution measurements- Non Destructive Infrared analysers, thermal conductivity and flame ionization detectors, analysers for NOx, gas chromatograph, Alternative Fuels- Hydrogen, Natural gas, Liquefied petroleum gas, vegetable oil and biodiesel, Biomass Energy, Direct Energy conversion methods- solar cells, thermo ionic converters.

References:

1. Ganesan V., Internal Combustion Engines, Tata Mcgraw-hill Education, New Delhi, 2012.
2. Mathur M. L. and Sharma R. P., Internal Combustion Engines, Dhanpat Rai Publications, New Delhi, 2011.
3. Colin R Ferguson and Allan T Kirkpatric, Internal Combustion Engines, Wiley India Ltd, New Delhi, 2004.

**AAE 4302: INTRODUCTION TO AUTOMOBILE
ENGINEERING [2 1 0 3]**

Introduction- Engine classifications, Cylinder arrangements, Engine components, Valve operating mechanisms, valve timing diagrams, fuel supply system, Battery ignition system, types of cooling and lubrication system, classification and working of clutch system, design of clutch components, Sliding and constant mesh gear box, Calculation of power, gear ratio and tractive efforts, Propeller shaft, Differential, Steering mechanism and geometry, types of suspension system, types of brakes, calculation of brake torque and stopping distance, Starting and lighting circuit.

References:

1. Heldt.P. M., High-Speed Combustion Engines, Oxford and IBM Publishers Co, 1985.
2. Newton and steeds, The Motor Vehicle, ELBS, 1980.
3. Narang G. B. S., Automobile Engineering, Khanna Publishers, 1990.
4. Kirpal Singh, Automobile Engineering, Vol. I & II, Standard Publishers Distributors, New Delhi, 1997.

AAE 4303: INTRODUCTION TO AEROSPACE ENGINEERING [2 1 0 3]

Introduction and Overview of The History of Flight, Fundamental Thoughts, Ballooning, Basic/Constructive Principles of Fluid Mechanics-Bernoulli's Theorem and Control Volume Approaches, The Sources of all Aerodynamic Forces, Equation of State for a Perfect Gas, Specific Volume, Anatomy of Aircraft and Space Vehicles, Standard Atmosphere, Hydrostatic Equation, Relation between Geopotential and Geometric Altitudes, Basics of Aerodynamics, Air foil Nomenclature, Lift, Drag and Moment Coefficient, Elements of Airplane Performance, Astronautics, Basics of Propulsion.

References:

1. Anderson Jr. J. D., Introduction to Flight, McGraw Hill International Edition, 2012.
2. Dava Newman, Interactive Aerospace Engineering and Design, McGraw Hill International Edition, 2002.
3. Kermode A. C., Flight without Formulae, Pearson Education (United Kingdom), 1990.
4. Howard D Curtis., Orbital Mechanics for Engineering Students, Butterworth Heinemann, 2013.
5. Anderson Jr. J. D., Fundamentals of Aerodynamics, McGraw Hill International Edition, 2017.

**AAE 4304: INTRODUCTION TO AVIONICS AND
NAVIGATION SYSTEMS [2 1 0 3]**

Introduction to aircraft, Introduction to flight mechanics and flight dynamics of aircraft & UAV, Introduction to Avionics in aircraft & spacecraft., Displays, HMI, I/O Devices and Power, Packaging, do 178B/C Software, ARINC and DOD Types, System Cooling, EMI/EMC Requirements; Aircraft Power Systems: Electrical Power Generation and Distribution Systems, Digital Communication, Digital Data Bus System, ARINC-429,629, AFDX, MIL-STD-1553, Fiber Optic Comm. Satellite Communication, Flight control laws, FBW, Autopilot, FMS, LRU, IMA & Mission Systems. Inertial Sensors and Inertial Navigation Systems, Multisensory Navigation Systems, Kalman filter basics & Mechanization. Elements of Navigation Systems, Satellite Navigation Systems, Antenna Design, Analysis and placement on aerospace vehicle, Aircraft circuit design on proteas, Radar & Landing Systems.

References:

1. Myron Kayton & Walter R. Fried, Avionics Navigation Systems, (2e), Wiley-Interscience, 1997.
2. Siouris G. M., Aerospace Avionics systems: A Modern Synthesis, Academic Press, 1993.
3. Collinson R. P.G., Introduction to Avionics Systems, Springer, 2002.
4. Cary R. Spitzer, Digital Avionics Handbook, (2e), Avionics Development and Implementation, CRC Press, Taylor & Francis Group, 2007.
5. Ching-Fang Lin, Modern Navigation, Guidance, and Control Processing, Prentice Hall, 1991.
6. Cundy Dale R., Introduction to Avionics, Pearson Education India, 2010.



OPEN ELECTIVES

MCA 4301: INTRODUCTION TO DATABASE SYSTEMS WITH MYSQL [3 0 0 3]

Modeling and Designing Databases, Database Design Process, Entity-Relationship Model, Basic Concepts, Constraints, Design of ER database schema, Reduction of ER to schema, Relational model, Super, candidate, primary, foreign key, Schema Diagram, Relational Database design, Functional dependencies, Normal forms, Creating a MySQL Database, Table, Modifying table, constraints, indexes, Basic SQL, Inserting Data, Selecting Data, Updating Data, Deleting Data, MySQL Functions, Numeric, String, Date /Time, Advanced Queries, Sorting, Multiple tables, Inner Join, Left Join, Right Join, Natural Join, Nested queries, Generating summaries, COUNT(), MIN(), MAX(), SUM(), AVG(), Group By, Statistical techniques, Calculating Descriptive statistics, Per-Group Descriptive Statistics, Generating frequency distribution, Calculating correlation coefficients, assigning ranks, Stored routines, stored procedure, stored function, Triggers, Events to schedule Database actions, Managing users and privileges, Importing and Exporting data, importing data with LOAD data and mysql import, importing csv files, exporting query results, tables, importing XML.

References:

1. Paul Dubois, MySQL Cookbook, O'REILLY, First Edition, 2007.
2. Larry Ullman, Visual Quick Start guide MySQL, Pearson Education, 2nd Edition, 2007.
3. Seyed M. M, Saied Tahaghoghi and Hugh Williams, Learning MySQL, O'Reilly, 2006.
4. Russell J.T. Dyer, MySQL in a Nutshell, O'REILLY, 2nd Edition, 2008.

MCA 4302: INTRODUCTION TO VR AND AR TECHNOLOGIES [3 0 0 3]

Introduction: Input Devices, Output Devices, Displays, Computing Architectures for VR, The Rendering Pipeline, PC Graphics Architecture, Workstation-Based Architectures, Distributed VR Architectures, Modeling, Geometric Modeling, Physical Modeling, Behavior Modeling, Model Management, VR Programming and other Toolkits. Introduction to Unity 3D Engine, 2D Game concepts and basic scripting, 3D Game concepts and environment creation, Advanced game concepts. Introduction to Unity AR: Foundation and Vuforia, working with Vuforia in Unity, ARCore in unity, Mini project on AR. Introduction to VR, Unity for Google cardboard, Basic VR app development for Cardboard, Develop for a specific VR platform.

References:

1. Jonathan Linowers, Krystian Banbilinski, Augmented Reality for Developers, Packt Publishers, 2017.
2. Edward Lavieri, Getting started with Unity 5, Packt publishing, 2015.
3. Grigore C. Burdea, Philippe Coiffet, Virtual Reality Technology, Wiley-IEEE Press, 2003.
4. Sherman, W.R. & A. Craig, Understanding, Virtual Reality: Interface, Application and Design, Morgan Kaufmann, San Francisco, CA, 2003.
5. Philippe Fuchs, Guillaume Moreau, Pascal Guitton, Virtual Reality: Concepts and Technologies, CRC, Taylor and Francis, 2011.

MCA 4303: INTRODUCTION TO LINUX AND SHELL SCRIPTING [3 0 0 3]

Introduction to UNIX/LINUX Operating System: OS concepts, Linux overview, key features of Linux, pros and cons of Linux. Processes: Processes and Files, I/O redirection and pipes, process creation, process attributes standard process file descriptors. File and Process

commands. File systems: Files and directories, file naming and wildcards, file attributes, file permissions. Regular Expressions & filters: find, grep, cut, sort, grep patterns. AWK and SED. Shell and Shell Scripting: The need for shell, types of shells, interactive uses of shell, using shell for creating user commands, functions. Bash shell features: Statements, data structure, built-in commands, environment customization primitives. Linux Editors.

References:

1. Richard Blum and Christine Bresnahan, Linux Command Line Shell Scripting BIBLE, 3rd Edition, Wiley, 2015.
2. Mark Sobel. A Practical Guide to Linux commands Editor and shell programming, Prentice Hall, 2nd Edition, 2010.
3. Stephen G. Kochan. Unix Shell Programming, 3rd Edition, SAMS Publications, 2003.
4. Bash Reference Manual Download able from GNU Project.
5. Brian W Kerningham and Rob Pike. The Unix Programming Environment, PHI Learning Pvt. Ltd., 2009.

MCA 4304: INTRODUCTION TO DATA ANALYTICS [3 0 0 3]

Introduction - data science, need for analytics, steps in data analysis projects, Data- sources of data, data sets, data warehouses, data types, privacy and confidentiality, samples vs. population. Data summarization and visualization – tables and graphs. Data Preprocessing- cleaning, transformation, dimensionality reduction. Data Analysis and Visualization – descriptive, inferential statistics, uni-variate and multi-variate analysis. Grouping – Cluster Analysis- distance measures, partitioning, hierarchical, density based methods. Market Basket Analysis, Association Analysis, Market Basket Analysis. Classifiers- Bayesian, k-nearest neighbor, neural network, Support Vector Machine, Decision Trees. Prediction- Regression models, Evaluating Classification and Predictive performance, ensemble methods. Anomaly Detection. Forecasting models.

References:

1. Glenn J. Myatt, Wayne P. Johnson, Making Sense of Data I: A Practical Guide to Exploratory Data Analysis and Data Mining, 2nd Edition, John Wiley & Sons Publication, 2014.
2. Glenn J. Myatt, Wayne P. Johnson, Making Sense of Data II: A Practical Guide to Data Visualization, Advanced Data Mining Methods, and Applications, John Wiley & Sons Publication, 2009.
3. Galit Shmueli, Nitin R. Patel, and Peter C. Bruce, Data Mining for Business Intelligence, John Wiley & Sons, 2014.
4. Ian H. Witten, Eibe Frank, Mark A. Hall, Data Mining: Practical Machine Learning Tools and Techniques, Morgan Kaufmann, 2011.
5. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining, Pearson Addison Wesley, 2005.

Minor Specialization: Computational Mathematics

MAT 4051: APPLIED STATISTICS AND TIME SERIES ANALYSIS [2 1 0 3]

Stochastic and deterministic dynamic mathematical models – forecasting and control, transfer function models, models for discrete control systems. Basic ideas in model building- linear and multiple linear regression. Basic concepts in stochastic processes and Markov chains, Mean square distance, mean square error prediction, prediction of covariance stationary process, ergodic theory and stationary process, applications of ergodic theory, spectral analysis of covariance stationary processes, Gaussian systems, stationary point processes, level crossing problems. ARIMA models, Autoregressive models, moving average models, duality, model properties, parameter estimates, forecasts. Volatility models: ARCH and GARCH modelling, testing strategy for heteroscedastic models, volatility forecasts, Black Scholes model.

References:

1. G.E.P.Box, G. M. Jenkins, G. C. Reinsel and G M Ljung, *Time Series Analysis-Forecasting and Control*, (5e), Wiley Series, 2016.
2. Anderson T W, *The Statistical Analysis of Time Series*, John Wiley, New York, 1994
3. Samuel Karlin, Howard M Taylor, *First Course in Stochastic process*, Academic Press, New York,
4. C. Chatfield, *The Analysis of Time Series – An Introduction*, Chapman and Hall / CRC, (4e), 2004
5. David Ruppert, *Statistics in Finance*, Springer Publications, 2004

MAT 4052: COMPUTATIONAL LINEAR ALGEBRA [2 1 0 3]

Matrix Analysis: Basic Ideas from Linear algebra, vector norms, matrix norms, orthogonality and SVD, Projections and CS decomposition, the sensitivity of square linear systems. General Linear Systems: Triangular systems, The LU factorization, Round off analysis of Gaussian elimination, Pivoting, Improving and estimating accuracy. Orthogonalization and least squares: Householder and Givens matrices, The QR factorization, The full rank LS problem, Other orthogonal factorizations, The rank deficient LS problem, Weighing and iterative improvement, square and underdetermined systems. The symmetric Eigen value problem: Eigen values properties and decompositions, Power iterations, the symmetric QR algorithm, Jacobi methods, Tridiagonal Methods, Computing the SVD, some generalized eigen value problems.

References:

1. Gene H. Golub and Charles F. Van Loan, *Matrix Computations*, (4e), Johns Hopkins University Press, 2013.
2. Gilbert Strang, *Linear Algebra and its applications*, (4e), Wellesley Cambridge press, 2009.
3. David S. Watkins, *Fundamentals of Matrix Computations*, (3e), Wiley, New York, 2010.
4. Roger a Horn, *Matrix Analysis*, (2e), Cambridge University Press, 2013.

MAT 4053: COMPUTATIONAL PROBABILITY AND DESIGN OF EXPERIMENTS [2 1 0 3]

Sampling and sampling distributions, Most powerful tests, Uniformly most powerful tests, Likelihood ratio tests, The sequential probability ratio test, Randomized Designs, Inferences about the differences in Means, Paired Comparison Designs, Inferences about the variance of normal distributions, Monte Carlo estimation methods. The analysis of variance, RCBD, LSD and Related Designs, The Graeco - Latin square Design, Balanced Incomplete Block Designs, PBIBD Introduction to Factorial Designs, The Two Factor factorial design, Blocking in a factorial

design, 2^k Factorial Design, Blocking and Confounding in the 2^k Factorial Design, Partial Confounding. Two level fractional factorial designs, three level and mixed level factorial and fractional factorial designs, 3^k Factorial Design, Confounding in the 3^k Factorial Design, Fractional replication of the 3^k Factorial Design, Factorials with mixed levels.

References:

1. Robert V Hogg and Allen Craig, *Introduction to Mathematical Statistics*, (4e), Macmillan
2. M N Murthy, *Sampling Theory and Methods*, Statistical Publishing Society, 1967
3. C Radhakrishna Rao, *Linear Statistical Inference and its applications*, (2e), Wiley Series.
4. Douglas C Montgomery, *Design and Analysis of Experiments*, (8e), Wiley Series, 2012,
5. D D Joshi, *Linear Estimation and Design of Experiments*, New Age International Publishers, 2009

MAT 4054: GRAPHS AND MATRICES [2 1 0 3]

Graphs and subgraphs, walks, paths and connectedness, distance as a metric, degrees, regular graphs, cubic graphs, bipartite graphs, self-complementary graphs, operations on graphs, extremal graphs, cut points, bridges and blocks, block graphs and cut point graphs. Trees and their characterizations, centres and centroids, block-cut point trees, spanning trees, independent cycles and cocycles, connectivity and line connectivity, graphical variations of Menger's theorem. Traversability: Eulerian graphs and Hamiltonian graphs. Line graphs and total graphs. Line graphs and traversability, coverings and independence, critical points and lines. Planarity: Plane and planar graphs, outer planar graphs, Kuratowski's theorem, vertex colouring. Incidence Matrix: Rank, minors, path matrix, 0-1 incidence matrix. Adjacency Matrix: Eigen values of some graphs, determinant, bounds, energy of a graph, antiadjacency matrix of a directed graph, non-singular trees. Laplacian Matrix: Basic properties, computing Laplacian eigen values, matrix tree theorems, bounds for Laplacian spectral radius, edge-Laplacian of a tree.

References:

1. F. Harary, *Graph Theory*, Narosa Publishers, 1988.
2. J.A Bondy and U.S.R Murthy, *Graph Theory with Applications*, (5e), Elsevier Publishing Co., 1982.
3. D.B. West, *Introduction to Graph Theory*, Pearson Education, Inc., 2001.
4. R.B Bapat, *Graphs and Matrices*, Hindustan Book Agency, 2010.
5. Lowell W Beineke and Robin J Wilson, *Topics in Algebraic Graph Theory*, Cambridge University Press, 2005.

OPEN ELECTIVES

MAT 5301: APPLIED GRAPH THEORY [2 1 0 3]

Graphs and applications of the theorems by Havel and Hakimi, Erdos and Gallai. Cut points, bridges and blocks, block graphs and cut point graphs. Trees and their characterizations, centre and centroids, block-cut points trees, spanning trees, independent cycles and cocycles, connectivity and line connectivity, Whitney's theorem. Traversability-Eulerian, Hamiltonian, line graphs and total graphs. Traversability, coverings and independence, theorem of Gallai, critical points and lines. Planarity, genus, thickness, crossing number. Colorability, chromatic number and its bounds, Nordhaus Gaddum theorems, the four and five colour theorems, chromatic polynomial. Matrix Representation -Incident matrix, Adjacency matrix, cycle matrix, cutset matrix, path matrix, Digraphs, Matrix - tree theorem on number of spanning trees. Tournament. Graph theoretic Algorithms: Computer representation of graphs-Input and output, Algorithms for connectedness, Spanning Tree, Fundamental Circuits, Directed Circuits and Shortest paths.

References:

1. F. Harary, *Graph theory*, Narosa Publishers
2. Narsingh Deo, *Graph theory with applications to Engineering and Computer Science*, Prentice Hall.
3. Robin J. Wilson, *Introduction to Graph theory*, Logman

MAT 5302: APPLIED LINEAR ALGEBRA [2 1 0 3]

Finite dimensional vector spaces, subspaces, linear independence, basis and dimension. Sum and intersection of subspaces. Algebra of linear transformations, range and null space of a linear transformation, Inner-product spaces, metric spaces and Banach spaces, Gram Schmidt orthogonalization, linear operators and their adjoint, self adjoint, unitary and normal transformations, polar decomposition. Matrix algebra, simultaneous equations, Eigen values, characteristic vectors, Cayley-Hamilton theorem, minimal polynomial, Application of eigen values to solve simultaneous difference and differential equations. Quadratic forms and their classification, constrained optimization. Some computational methods of linear algebra.

References:

1. Gantmacher F.R., *The Theory of Matrices*, Chelsea.
2. Gilbert Strang, *Linear Algebra and its applications*, Thomson Learning
3. David C. Lay, *Linear Algebra and its applications*, Pearson Education

MAT 5303: APPLIED NUMERICAL METHODS [2 1 0 3]

Matrix Algebra : Solution for linear system of equations – Direct methods: Gauss elimination method, Gauss Jordan method, Crout's (LU decomposition) method. Iterative methods, Jacobi Gauss Seidel and successive over relaxation methods. Computation of inverse of a matrix: Jordan method, Triangularization method, Choleski's method, partition method. Eigen value & Eigen vectors: Given's method for real symmetric matrices, Jacobi's method for real symmetric matrices, Power method. Numerical Solution of Ordinary Differential Equations: Single step methods, Runge-Kutta method, Adam-Bashforth's predictor-corrector method, Milne's predictor and corrector method. Numerical Solution of Partial Differential Equations: Finite difference approximation to derivatives of Parabolic, Elliptic. Explicit finite difference method, implicit method.

References:

1. Jain, Iyengar and Jain: *Numerical methods for Scientific and Engineering Computations*, New Age Publishers
2. Carnahan, Luther and Wikes: *Applied Numerical Methods*, John Wiley
3. Conte S.D and Boor, *Introduction to Numerical analysis*, McGraw Hill.

MAT 5304: MATHEMATICAL MODELLING [2 1 0 3]

Introduction, Techniques, classification and characteristics of mathematical models, mathematical modeling through algebra, ordinary differential equations of first order. Mathematical modeling through systems of ordinary differential equations of first order, Prey-Predator model. Mathematical modeling through systems of ordinary differential equations, modeling in medicine. A model for diabetic mellitus. Modelling

on population dynamics. Mathematical modelling through difference equations. Some simple models. Modelling of economics and finance through difference equations, population dynamics and generation of models through difference equations, modeling in probability theory, examples. Optimization models: Mathematical modeling through linear programming. Mathematical modelling through graphs: elements of graphs, digraphs. Mathematical models for blood flow. Mathematical model for Peristaltic transport of two layered.

References:

1. J N Kapur, *Mathematical Modelling*, New age international publishers, (2e), 2015.
2. J N Kapur *Mathematical Models in biology and medicine*, East-West press.
3. J N Kapur *Mathematical models of environment*, INS Academy, New Delhi

MAT 5305: OPTIMIZATION TECHNIQUES [2 1 0 3]

Formulation, Linear programming-simplex method, Penalty-coarse methods, 2-phase method. Dual Simplex method. Duality theory. Transportation problem-Vogel's approximation method, MODI method, Assignment problem-Hungarian method. Project Management - Networks, Project planning and control using PERT and CPM. Project crashing. Game theory - 2-persons zero-sum games, Minimax principle, games with mixed strategies. Dominance theory, solution using Linear programming.

References:

1. Bronson Richard - *Theory and Problems of Operations Research*- Schaum series- MGH
2. P.K. Gupta & Man Mohan - *Operations Research* - Sultan Chand & Sons
3. Hamdy A. Taha - *Operations Research* PHI

MAT 5306: STOCHASTIC PROCESSES AND RELIABILITY [2 1 0 3]

Static probabilities: Review and prerequisites generating functions, difference equations. Dynamic probability: definition and description with examples. Markov chains, transition probabilities, Chapman-Kolmogorov equations. Classification of states, chains of Markov process. Stability of Markov systems, limiting behaviour, random walk. Poisson Processes: assumptions and derivations, related distributions, birth and death processes. Queueing System, general concepts, Model M/M/1 and M/M/S, steady state behaviour, transient behaviour. Wiener processes and Gaussian processes. Differential equations of a Wiener process, Kolmogorov equations, Ornstein-Uhlenbeck Process. White noise. Reliability Theory: Definition of Reliability, types of failure, Hazard rate, Laws of failure - normal, exponential & Weibull failure laws - System reliability - in series, in parallel series - parallel system, Parallel-series system & related problems.

References:

1. Medhi, J., *Stochastic Processes*, Wiley Eastern.
2. Bhat U R, *Elements of Applied Stochastic Processes*, John Wiley.
3. A Papoulis, *Probability, Random Variables and Stochastic Processes*, McGraw Hill.

Minor Specialization: Business Management

HUM 4051: FINANCIAL MANAGEMENT [2 1 0 3]

Introduction and objectives of financial management, Evolution of corporate finance, responsibilities. Types of accounts, Golden rules of accounting, Preparation of Journal, Ledger, Trial balance and final accounts. Sources of long term finance, Characteristics of equity capital, Preference capital, Debenture capital & Term loans. Valuation of securities, Concepts, Bond valuation and related models, Bond value theorems, Yield to maturity. Equity valuation; Dividend capitalization approach, Leverage, Operating leverage, Financial leverage, Total leverage, Indifference point analysis. Working capital management, Capital budgeting: appraisal criteria, pay-back period, Average rate of return, Net present value, Benefit cost ratio and Internal rate of return. Risk analysis in capital budgeting, Cost of capital: introduction, cost of debt capital, Preference capital and Equity capital, Weighted average cost of capital, Determination of proportions, Cash management, Dividend decisions.

References:

1. Prasanna Chandra., Fundamentals of Financial Management, Tata McGraw Hill Education Pvt Ltd., New Delhi, 2006.
2. I M Pandey, Financial Management, Vikas Publishing House Pvt Ltd., New Delhi, 2015.
3. N Ramachandran & Ram Kumar Kakani, Financial Accounting for Management, 3/e, Tata McGraw Hill Education Pvt Ltd., New Delhi, 2011.
4. Eugene F Brigham & Michael C E, Financial Management: Theory and Practice. 12e, Cengage Learning, India, 2008.
5. Maheshwari S.N., Financial Management, Sultan Chand & Co., New Delhi, 2002.

HUM 4052: HUMAN RESOURCE MANAGEMENT [2 1 0 3]

Introduction, Scope of HRM, Objectives of HRM, Functions, Activities, Roles, HRD organization and responsibilities. Evolution of HRM, Influence of various factors on HRM. Human resource planning: Introduction, Strategic considerations, Nature and scope, Human Resources Inventory, Job analysis, Job design, Job description, Job specification and Job evaluation. Employee Recruitment & Selection: Policy, Process, Tests, modern methods, Interview, Provisional selection, Medical/Physical examinations, Placement, Induction programs and socialization. Training and development: Basic concepts, Employees training Process, Planning, Preparation of trainees, Implementation, Performance evaluation and Follow-up training. Competency Mapping and Career development programmes. Performance appraisal and Merit rating, Promotion, transfers and separations, Wages and salaries administration, Discipline and grievances. Industrial and labour relations and Trade Unionism Overview: Collective bargaining and maintaining Industrial health.

References:

1. Michael Armstrong ., A Handbook of Human Resource Management Practice: 10th Edition, New Delhi, Kogan Page India, 2006
2. Gary Dessler & Biju Varkey ., Human Resource Management: 12th Edition Dorling Kindersley (India), Noida, 2011
3. T.V. Rao and Pereira D F., Recent experiences in Human Resources Development, Oxford and IBH Publishing, 1986.
4. Subbrao A., Essentials of Human Resource Management and industrial Relations, Himalaya Publishing House, 1999.
5. Aswathappa K, Human Resource Management, Text & Cases McGraw Hill 7th Edition, 2006
6. N G Nair and Latha Nair., Personnel Management and Industrial Relations, S. Chand Company, 1995.

HUM 4053: MARKETING MANAGEMENT [2 1 0 3]

Marketing definition, scope and concepts, Adapting marketing to the New Economy, Marketing strategic planning. Market Demand, Marketing Environment, Marketing Information System, Marketing Research. Segmentation, Targeting and Positioning, Buying Behaviour: Consumer Markets and Business Markets, Competition: Identifying competitors, analysing competitors. Product Life Cycle: Product life-cycle marketing strategies. New Market Offerings: New product development and challenges, Branding. Designing and Managing Services, Price Strategies, Retailing, Wholesaling, Integrated Marketing Communications, Digital Marketing and Trends, International Marketing

References:

1. Philip Kotler, Kevin Keller, Abraham Koshy & Mithileshwar Jha, Marketing Management – A South Asian Perspective, Pearson Education Inc, New Delhi, 2012.
2. Arun Kumar & N Meenakshi, Marketing Management, Vikas Publishing House Pvt Ltd, New Delhi, 2011.
3. Varshney R L and Gupta S L., Marketing Management, Sultan Chand & Sons, New Delhi, 2004.
4. Adrian Palmer., Principles of Marketing, Oxford University Press, New York, 2000.

HUM 4054: OPERATIONS MANAGEMENT [2 1 0 3]

Introductions to operations management – process view and supply chain view, types of production activities, competitive priorities and capabilities. Break-even analysis, evaluating services or products, evaluating processes - make or buy decision, decision making under risk, and decision trees. Introduction to forecasting, importance and uses of forecasting, demand patterns, demand management options, judgement methods, causal methods - linear regression, time series method – naïve method, moving average, weightage moving average, and exponential smoothing curve. Planning long-term capacity, measures of capacity and utilization, economies of scale, diseconomies of scale, capacity timing and sizing strategies, sizing capacity cushions, timing and sizing expansion – expansionist strategy, wait and see strategy, and a systematic approach to long term capacity decision. Levels in operations planning and scheduling across the organization, sales and operation planning strategies- chase strategy, level strategy, operations planning using linear programming technique, scheduling job and facility scheduling, and work for scheduling. Theory of constraints, managing bottle necks in manufacturing and service processes, identifying bottle necks, relieving bottle necks, drum buffer rope system, and managing constraints in a line system. Supply chain design across the organization, supply chains for services and manufacturing, measures of supply chain performance - inventory measures, financial measures, inventory and supply chains - pressures for small inventories, pressures for large inventories, types of inventory, inventory reduction tactics, and inventory placement. Costs of quality, total quality management, acceptance sampling, statistical process control - control charts, and process capability. Continuous improvement using lean systems, different types of wastes, strategic characteristics of a lean system, designing lean system layout, and Kanban system.

References:

1. Krajewski L. J., Ritzman L. P., Malhotra M., and Srivastava S. K., *Operations Management*, 11th edition, Pearson Education (Singapore) Pvt. Ltd., Delhi, 2016.
2. Heizer J. and Render B., *Operations Management*, 11th edition. Pearson Education India, 2016.
3. Khanna R. B., *Production and Operations Management*, 2nd edition, PHI Learning Private Limited, 2015.

OPEN ELECTIVES

HUM 4301: COMMUNICATIVE ENGLISH [3 0 0 3]

(Offered for Lateral Entry Students only)

Common Errors in English: Subject Verb Agreement; Uses of Tenses / Sequence of Tense; Prepositions; Articles; Special Usages; Creative Writing Essay: Types of Essays, Argumentative Essay, Descriptive/ Expository/Narrative Essays; Reading Comprehension; Dynamic text; Critical Evaluation; Group Discussions; Presentation Skills; Essay writing.; Audio texts/speeches -Practice listening skills- summary, commentary, listening exercises. Video Speeches -Theme based speeches - motivational, informative, technical, and persuasive, discussions. Speech - Elements of a good speech, types of speeches, model speech, Speech exercises, individual presentations, peer and facilitator feedback. Formal/Informal communication. Communication Styles- formal and informal, standard English and variations in usages, examples and analysis of faulty usages; Correspondence: formal/informal letters and emails .

References:

1. Green David., *Contemporary English Grammar, Structures and Composition* Chennai: Macmillan Publications.
2. Thompson AJ & Martinet AB., *A Practical English Grammar*, OUP.
3. Turton N D , Heaton J B., *Longman Dictionary of Common Errors*, 1998.
4. Meenakshi Raman & Sangita Sharma., *Technical Communication; Principles and Practice*, Oxford University Press, 2011.

HUM 4302: FILM STUDIES [2 1 0 3]

History of invention of motion pictures - Daguerre, Muybridge, Edison, Skaldanowsky Brothers, Lumieres; Evolution of film – Lumieres, Melies, Porter, Griffith, Basic techniques – Mise-en-scene, Mise-en-shot, Deepfocus Photography, Longtake, Continuity, Editing, Montage, German Expressionism; French Impressionism; Soviet Montage cinema; Hollywood cinema, Italian Neo-realism; French Nouvelle Vague, Documentary, Directors – Eisenstein, Kurosawa, Godard, Chaplin, Bergman; Mohsen Makmalbaf, Majid Majidi, Keislowski, Zhang Yimou, Kim Ki Duk, “New Wave” Cinema in India - Bengali; Malayalam; Kannada; Hindi, To be screened- Bicycle Thieves, The 400 blows, Rashomon, Wild strawberries, Battleship Potemkin, Cabinet of Dr. Caligari, The kid, Children of heaven, Hero, Ghatashraddha, Pather Panchali, Mathilukal.

References:

1. Bordwell, David and Thompson, Kristin., *Film Art: an Introduction*, 7th ed. New York: McGraw-Hill Co., 2004.
2. Kavin, Bruce., *How Movies Work*. Berkeley and Los Angeles: University of California Press, 1992.
3. Cook, David A., *A History of Narrative Film*, 4th ed. New York: W.W. Norton & Co., 2004.

HUM 4303: GERMAN FOR BEGINNERS [3 0 0 3]

Text selections, dialogue and exercises which have been designed to give the absolute beginner grounding in the rudiments of the German language, as well as providing background information about the history, life and culture in Germany. Introduction to the German alphabet and the German language – dialogues & conversations – pronunciation, basic vocabulary lists - key points of grammar - background information about the history and culture of Germany - exercises on vocabulary, grammar and German culture - reading & listening comprehension.

References:

1. Sally Johnson, Natalie Braber., *Exploring the German Language*, (2E), Cambridge University Press. 2008.
2. Charles Russ., *The German Language Today: A Linguistic Introduction*, Routledge. 1994.

HUM 4304: BUILDING BRIDGES: INDO-EUROPEAN INTERCULTURAL DYNAMICS [3 0 0 3]

The challenges of Intercultural communication - interacting in a diverse world, understanding cultures, alternative views of reality, cultural stereotyping. Foundational Theories in Intercultural Communication - Edward Hall, Samovar, G Hofstede, Understanding cultural Dimensions and Cultural Stereotyping- collectivism/ individualism, power distance, masculine/feminine, cultural metaphors, Intercultural Business Communication Competence - The Role of Language in Intercultural Business Communication , Nonverbal Language in Intercultural Communication, Cultural influence on interpersonal communication, Intercultural Dynamics in the multicultural organizations.

References:

1. Dodd, Carley H. *Dynamics of Intercultural Communication*, McGraw-Hill, Boston. 1998.
2. Gannon M J and Pillai R. *Understanding Global Cultures*, Sage Publications, California. 2010.
3. Hall, E. T. *The dance of life: The other dimension of time*, Random House, New York. 1983.
4. Hofstede, Geert., *Cultures' Consequences, Comparing Values, Behaviors, Institutions, and Organizations across Nations*, Sage Publications, Thousand Oaks, CA. 2001.
5. Martin, J.N. & Nakayama, T.K., *Intercultural communication in contexts*. 4th Edition. Mountain View, CA: Mayfield. 2007.
6. Samovar, L A and Porter, R., *Communication between Cultures*, Cengage Learning, Wadsworth, CA. 2007.

HUM 4305: INTERPRETATION OF LITERARY TEXTS [3 0 0 3]

Texts-static, dynamic, cryptic and delphic ; Language of literature; Form and structure; Literature verses popular fiction; Text and discourse; Authors and critics; Theories and approaches to literary texts; Formalism, Structuralism, Marxism, Feminism, Deconstruction; Ideational functions and textual Functions; Class, gender and sexuality; Race and nationality; Genre, phonological deviations –sound patterns and figures of speech ; Pragmatic approach to literature; Understanding syntax, Lexical and syntactic analysis of literary texts; Point of view in literary texts and foregrounding; Prediction and making sense of a text; Stylistic analysis of a novel; Kinds of meaning, Rhetorical structure; Pragmatics and discourse analysis; Interpreting cohesive devices and complex functional values; Stylistic approach to literature ; Elements of literary style; Stylistic analysis of selected short stories, Poems, Novels and Plays; Genre, the plot setting, characterization, tone and themes; Stylistics and its implications on narrative techniques; Intertextuality and conceptual blending; Identifying patterns in the texts; Meaning making process in literature; Imagery, metaphor as a mode of thought; Coherence and Cohesion; Context, turn taking and Adjacency Pair; Pro-forms, Discourse markers, Lexical cohesion and presupposition; Recognizing text organization; Critical texts, Shared assumptions on critical texts; The role of schema and the concept of speech acts in literary texts.

References:

1. Austin, J.L., *How to do Things with Words*, Longman, London, 1992.
2. Barthes, R., *Introduction to the Structural Analysis of Narratives*, Fontana, London, 1977.
3. Blake.N.F., *An Introduction to the Language of Literature*, Macmillan, London. .1990.
4. Carter, R. (ed.), *Language and Literature: An introductory Reader in Stylistics*, Allen and Unwin, London, 1982.
5. Cook, G., *Discourse and Literature*, Oxford University Press, London, 1994.
6. Harold, C.M.(ed.), *Style in Prose Fiction*, Columbia University Press, New York.
7. Leech, G.N., *A Linguistic Guide to English Poetry*, Longman, London, 1969.

HUM 4306: PUBLIC SPEAKING [3 0 0 3]

Public Speaking -Introduction to Public speaking- Voice modulation, Sounds/accents (basics), Articulation, Anxiety management, Logical arguments, Concept of purpose, Audience, Smart use of Body language. Types of speech-Informative speeches - designing and delivery-Persuasive speeches – designing and delivery- Impromptu speeches – designing and delivery -Special occasion speeches- designing and delivery, Presentations - planning and execution -Types of presentation - Informative-Planning and delivery - Persuasive - Planning and delivery - Motivational - Planning and delivery, Other forms of speaking – Debates, Seminars, Panel Discussion, Group Discussion, Tall Tales, Turn Coat, Art of Evaluation-Providing feedback- planning, designing and delivering constructive feedback - Receiving feedback – making use of relevant feedback -Techniques of providing feedback- Speech analysis –Role of the Evaluator.

References:

1. Duarte Nancy., *Resonate: Present Visual Stories that Transform Audiences*, John Wiley and Sons, 2010.
2. Minto Barbara., *The Pyramid Principle: Logic in writing, thinking and Problem Solving*, Financial Times Prentice Hall, 2002.
3. Berkun Scott., *Confessions of a Public Speaker*, O'Reilly Media, 2009.
4. Goodale Malcolm., *Professional Presentations*, Cambridge University Press, 2005.
5. Carnegie Dale., *The Art of Public Speaking*, 1905.

HUM 4307: INTRODUCTION TO PSYCHOLOGY [3 0 0 3]

Psychology - Meaning, Nature and Scope, Defining Psychology, Meaning of the term Behavior, Nature of Psychology, Scope of Psychology: Branches and fields of Psychology. Development of Psychology - Historic Sketch of Psychology, Modern Age of Psychology, Gestalt Psychology, Psycho Analysis, Contemporary Psychology. Systems of Psychology- The Nervous System, Nature V/s Nurture, Sensation and perception, States of Consciousness. Methods of Psychology - Classical Conditioning, Introspection Method, Naturalistic Method, Experimental Method, Differential Method, Clinical Method, Psycho Physical Method. Personality- Personality types, Personality Disorders, Abnormal psychology, Treatment of personality disorders. Thinking - Nature of Thinking, Types of Thinking, Language and Intelligence. Discussion, Presentation and Assignments.

References:

1. Boring, E.G., Langfield, H.S. & Weld, H.P., *Foundations of Psychology*, Asia Publishing House, Calcutta, 1963.
2. Carson, R.C., Butcher, J.N. & Coleman, J.C., *Abnormal Psychology & Modern Life*, (8th ed) Scoff, Foresman & Co. 1988.
3. Lahey, B.B., *Psychology: An Introduction*, 6th Ed., Tata McGraw Hill, New York, 1965.
4. Olson, M.; Hergenhahn, B.R., *Introduction to the Theories of Learning*, Prentice-Hall India, 2009.

HUM 4308: INTRODUCTION TO PHILOSOPHY, RELIGION AND CULTURE [3 0 0 3]

Notions of Philosophy; The Origin and Development of Philosophy; Ancient Philosophy; Medieval Philosophy; Modern Philosophy; Contemporary Philosophy; Indian Philosophy; Comparative Religion; Western Philosophy; The Relevance of Philosophy; Branches of Philosophy; Methods of Philosophy; Philosophy and other Branches of Study; Some Problems of Philosophy; Themes of Philosophy; Mind and Body, and the Problem of Universal; Change/Movement time and place; Existence of God and Evolution; Indian Culture; Social Ethics; Logic and Scientific Methods; Philosophy of Language.

References:

1. Aquinas, Thomas., *On Being and Essence. Trans. Armand Maurer.* Canada: Pontifical Institute of Mediaeval Studies, 1968.
2. John-Terry, Chris., *For the Love of Wisdom: An Explanation of the meaning and Purpose of Philosophy.* New York: Alba House, 1994.
3. Maritain, Jacques., *An Introduction to Philosophy*, London: Sheed and Ward. 1979.
4. Radhakrishnan, S. (Ed)., *History of Philosophy Eastern and Western Vol. II* George Allen and Unwin Ltd., London, 1953.
5. Wallace, William., *The Elements of Philosophy.* New York: Alba House, 1990.

HUM 4309: CREATIVE WRITING [3 0 0 3]

Various literary/prose forms and their characteristics; techniques and strategies for reading; nuances of language and meaning in reading and writing; Writing Exercises - techniques and strategies of writing creatively; Critical Concepts and Terms in Literary Writing; Writing Exercises; creative writing output.

References:

1. Milan Kundera ., *The Art of the Novel.*
2. The Art of Fiction: Illustrated from Classic and Modern Texts, David Lodge

HUM 4310: GRAPHIC NOVELS: HISTORY, FORM AND CULTURE [3 0 0 3]

Part I: The History of Comic Books, Part 1: Developing a Medium Defining comic books as a medium-Relationships between comic books and other forms of sequential art-The (continental) roots of comics as an art form -The ways in which comic strips and pulps contributed to the emergence of the comic book. The History of Comic Books, Part 2: The Maturation of the Medium-Influence of underground movement, ways in which mainstream publishers began to address more relevant topics, proliferation of independent comics, the increase in the profile and prominence of the medium due to ambitious projects. Part II: Creating the Story: Graphic Storytelling and Visual Narrative-Some narrative structures commonly found in comic books -The types and techniques of encapsulation-The nature of the relationship between the pictorial and linguistic elements of comic books Experiencing the Story: The Power of Comics - About diegetic images that show the world of the story-About interpretive images that comment on the story-The impact art style has on the emotional reactions of the reader; and how the meaning of each image is affected by the relationship to other images in that particular book, in other texts, and in the reader's personal experience-Part III: Comic Book Genres-the definition of genre and the role it plays in shaping the creation of comics products- the characteristics of genres, including character types, narrative patterns, themes, and other conventions-how the example genres of teen humor, romance, funny animals, horror, and memoir developed in comics, and what characterizes each-how the hybridization of genres helps experimentation and expansion of narrative possibilities.

References:

1. Roger Sabin., *Comics, Comix and Graphic Novels.*
2. Robert Petersen, Allan Moore., *Comics, Manga and Graphic Novels: A History of Graphic Narrative*3. *Comics as Performance, Fiction as Scalpel.*
3. Jeet Heer, Kent Worcester., *Arguing Comics: Studies in Popular culture.*

HUM 4311: MANAGEMENT INFORMATION SYSTEMS [3 0 0 3]

Management information system: Introduction to management, information and system. System concepts, general model of a system and types of systems. Evolution of MIS, models and resources used in the MIS model. Structure of MIS, operating elements of an information system, synthesis of the structure. Information systems for different applications: Transaction processing systems, Human resource management systems and Marketing-application areas. Production planning and Office automation systems. Role of management information in decision making: Concepts of decision making, Decision making process and information needs at different levels of management. Herbert. A. Simon model. Phases in the decision making process, Programmed vs non-programmed decisions, General model of human as an information processor, Allen Newell Simon model. Decision support systems -structure, elements and working. Information as a strategic resource. MIS as a technique for making programmed decisions: Behavioral models of the decision maker and methods. MIS support for decision making. Role of MIS in Organizations -recent trends and e-commerce applications. Development of customized management information system approaches: SDLC -phases in SDLC, Strategic and project planning for MIS, conceptual design and detailed design phases: general business planning and MIS response. MIS Planning and planning cycle. Conceptual system design and Detailed System design. MIS System Implementation, and Pit falls: Pit Falls in MIS development, Fundamental weaknesses, soft spots in planning, design problems and review.

References:

1. Gordon B. D. and Margrethe H. O., (2005), "Management Information Systems", McGraw-Hill, New York.
2. Kenneth L. and Price J. P., (2003), "Management Information Systems", Macmillan.
3. Jawadekar W. S., (2000) "Management Information System", Tata McGraw Hill.
4. Senn J. A., (2003), "Analysis & Design of Information System", McGraw Hill International Student Edition.
5. Mudrick; Ross (1997) "Information Systems for Modern Management" Prentice Hall of India.
6. James A. O'Brien (1995) "Management Information Systems, Galgotia Publications.

HUM 4312: ENTREPRENEURSHIP [3 0 0 3]

Entrepreneur: Meaning of entrepreneur, evolution of the concept, functions of an entrepreneur, types of entrepreneur, and intrapreneur. Concept of entrepreneurship - evolution of entrepreneurship, development of entrepreneurship, stages in entrepreneurial process, role of entrepreneurs in economic development, entrepreneurship in India, barriers for entrepreneurship. Small scale industry: Definition, characteristics, need and rationale. Objectives, scope, role of Small Scale Industries (SSI) in economic development, advantages of SSI, steps to start an SSI - government policy towards SSI, different policies of SSI, impact of liberalization, privatization, and Globalization. Effect of WTO/GATT and supporting agencies of government for SSI. Institutional support: Different Schemes: TECKSOK, KIADB; KSSIDC; KSIMC; DIC Single Window Agency: SISI, NSIC, SIDBI, and KSFC, New schemes and support for start-ups and new venture under Govt. of India. Preparation of Business plan and project report: components of a successful plan. Meaning of project, project identification, project selection, project report, need and significance of report, contents, formulation, guidelines by planning commission for project report. Network analysis, errors in project report, project appraisal. Identification of business opportunities, market feasibility study, technical feasibility study, financial feasibility study and social feasibility study and documentation and evaluation.

References:

1. Vasant Desai., Dynamics of Entrepreneurial Development & Management, Himalaya Publishing House, 2007.
2. David H. Holt Entrepreneurship: New Venture Creation, Published by prentice Hall, 1991.
3. Poornima. M. Charantimath., Entrepreneurship Development, Pearson Education, 2006.
4. S.S. Khanka., Entrepreneurship Development, S.Chand& Co, 2007.



Minor Specialization: Material Science

PHY 4051: PHYSICS OF LOW DIMENSIONAL MATERIALS [3 0 0 3]

Thin films: Thick and Thin Film Materials, preparation by physical and chemical methods. Thickness measurement techniques. Theories of nucleation - Capillarity and atomistic theory, effect of deposition parameters on nucleation and growth of thin films. Epitaxial growth. Reflection and Transmission at interface between isotropic transparent media. Reflectance and Transmittance in thin films. Antireflection coatings. Electrical conduction in discontinuous metal films - Quantum mechanical tunneling model. Conduction in continuous metal and semiconducting films. Thermoelectric power in metal films. thin film resistors, thermopiles. Quantum well devices.

Nanomaterials: Chemical Synthesis of Nanoparticles: Bottom up approach. Functionalized nanoparticles in different medium. Size control. Self assembly. Nanoparticle arrays. Semiconductor nanoparticles- synthesis, characterization and applications of quantum dots. Magnetic nanoparticles- assembly and nanostructures. Manipulation of nanoscale biological assemblies. Carbon nanotubes and fullerene as nanoclusters. Nanostructured films. Physical Methods of Nanostructure Fabrication: Top down approach. Nanopatterning- Lithography- Optical, X-ray and Electron beam lithography. Ion- beam lithography.

References:

1. Chopra K. L., *Thin Film Phenomena*, Mc Graw Hill, 1969
2. Milton Ohring, *Materials Science of Thin Films*, Elsevier, 2001
3. Heavens O. S., *Optical Properties of Thin Solid Films*, Dover, 1955
4. Liz-Marzan L. M. and Kamat P. V. (Eds), *Nanoscale Materials*, Kluwer, 2003
5. Nalwa H. S. (Ed), *Nanostructured Materials and Nanotechnology*, Academic, 2002

PHY 4052: PHYSICS OF PHOTONIC AND ENERGY STORAGE DEVICES [3 0 0 3]

Semiconductors: Direct and indirect band gaps. Carrier concentrations at thermal equilibrium. Fermi level. Degenerate and non-degenerate semiconductors. Semiconductor Crystal growth techniques Contact phenomenon- semiconductor-semiconductor, metal-semiconductor contacts. Schottky and Ohmic contacts. Preparation of semiconductor devices. IC technology, elements of lithography.

Photonic Devices: LED and semiconductor lasers: Radiative and non-radiative transitions, diode laser, population inversion, laser operating characteristics, efficiency, photoconductor, photodiode, avalanche photodiode, phototransistor, material requirement for solar cells, theory and types of solar cells.

Fuel cells: Hydrogen energy – merits as a fuel – production of hydrogen, Hydrogen Fuel cells – introduction – difference between batteries and fuel cells, components of fuel cells, principle of working of fuel cell, fuel cell stack, fuel cell power plant: fuel processor, fuel cell power section, power conditioner, Advantages and disadvantages of fuel cell power plant. Types of fuel cells. Application of fuel cells – commercially available fuel cells.

References:

1. Neamen Donald A., *Semiconductor Physics and Devices, basic principles*, Tata McGraw-Hill, 2002
2. Sze S. M., *Physics of Semiconductor Devices*, John Wiley & Sons, 2007
3. Larminie J. and Dicks A., *Fuel Cell Systems Explained*, Wiley, 2003
4. Xianguo Li, *Principles of Fuel Cells*, Taylor and Francis, 2005
5. S. Srinivasan, *Fuel Cells: From Fundamentals to Applications*, Springer, 2006

OPEN ELECTIVES

PHY 4301: FUNDAMENTALS OF ASTRONOMY AND ASTROPHYSICS [3 0 0 3]

Introduction to astronomy and astrophysics. Properties of ordinary stars: Brightness of starlight; the electromagnetic spectrum; Colours of stars; stellar distances; absolute magnitudes; HR diagram. Stellar evolution: Formation of star; the main sequence; stellar structure; evolution off the main sequence; planetary nebulae; white dwarfs. The death of high mass stars: Supernovae; neutron stars; pulsars; stellar black holes. Normal Galaxies: Types of galaxies; Dark matter in galaxies. Cosmology: The scale of universe; expansion of the universe; open or closed universe; the big bang; the cosmic background radiation; big bang nucleosynthesis. Astronomical instruments.

References:

1. Marc L Kutner, *Astronomy: A physical Perspective (2e)* Cambridge University Press, 2003
2. Baidyanath Basu, *An Introduction to Astrophysics (2e)*, PHI Learning Pvt. Ltd, 2011.
3. Michael Zeilik, *Introductory Astronomy and Astrophysics (4e)*, Saunders College Pub. 1992.

PHY 4302: PHYSICS OF ENGINEERING MATERIALS [3 0 0 3]

Types of magnetism, ferromagnetic domains, soft and hard magnetic materials, ferrites, magnetic storage, Superconducting materials, Applications of superconductors, Nano-materials, bottom-up and top-down methods, Quantum dots and nano-carbon tubes, Composite materials, micromechanics of composites - Density, Mechanical and Thermal properties, Semiconductors, Metals, semiconductors and insulators, Direct and indirect band-gap semiconductors, Intrinsic and extrinsic semiconductors, Diffusion and drift processes, Crystal growth techniques, Preparation of semiconductor devices.

References:

1. William F. Smith, *Principles of Materials Science and Engineering (2e)*, McGraw-Hill International Edition, 1990.
2. Nalwa H.S., *Nanostructured Materials and Nanotechnology (2e)*, Academic, 2002.
3. Chawla K. K. *Composite Materials- Science & Engineering (3e)*, Springer-Verlag, 2012.
4. Streetman Ben G. and Banerjee Sanjay Kumar, *Solid State Electronic Devices (6e)* PHI learning Private Limited, 2012.

PHY 4303: RADIATION PHYSICS [3 0 0 3]

Radiation Sources: Fast electron sources-Heavy charged particle sources-Sources of electromagnetic radiation-Neutron sources. Radiation Interaction: Photoelectric and Compton process -pair production. Interaction of heavy charged particles-stopping power-Energy loss characteristics- Bragg curve-Particle range-range straggling- stopping time-energy loss in thin absorbers-Interaction of fast electrons-absorption of beta particles-interaction of gamma rays-gamma ray attenuation-Interaction of neutrons-neutron cross section-neutron induced nuclear reactions. Radiation Detectors and Instrumentation: Semiconductors diodes-JFET-MOSFET-Integrated Circuits-OPAMP and their characteristics-Differential Amplifier-Operational amplifier systems-Pulse Amplifiers. Principles of radiation detection and measurements-Gas filled detectors-Ionisation chambers-Proportional counters-GM counters-Scintillation detectors-Semiconductor detectors-Thermo luminescent Dosimeters-Radiation spectroscopy with scintillators-Gamma spectroscopy-Multichannel pulse analyzer-Slow neutron detection methods-Reactor instrumentation. Industrial uses of nuclear measurements: Radiation detection in industrial environments-Measuring systems for industrial problems-Determination of physical material characteristics by nuclear measurements-Level height determination-Density measurements-Quantity measurements-Thickness measurement-coating thickness measurement.

References:

1. Knoll G. F., *Radiation Detection and Measurement (3e)*, Wiley 2010
2. Boylestad R. L., *Electronic Devices and Circuit theory (11e)*, Pearson Education 2016
3. Malvino A. P., *Electronic Principles (7e)*, TMH 2010
4. Foldiak G., *Industrial Applications of Radioisotopes*, Elsevier Science Ltd 1986

PHY 4304: SOLID STATE PHYSICS [3 0 0 3]

Review of Crystal structure: Lattice, basis and unit cell, crystal system, symmetry, crystal planes and miller indices, reciprocal lattice, Bragg's law, experimental methods of x-ray diffraction, types of crystal binding, analysis of stress and strain in crystals. Electrical conduction: Free electron gas model, Sommerfeld quantum theory, Fermi energy, parameters of free electron gas at absolute zero, electrical conductivity, Drude-Lorentz theory and Sommerfeld theory of electrical conductivity, Band theory of solids, electrical conduction in metals, insulators and semiconductors. Dielectrics: Static dielectric constant, polarization and polarizability, local field, ferroelectricity, piezoelectricity, frequency dependence of polarizability (electronic, ionic and dipolar), dielectric losses, requirements of insulating materials, applications of dielectric materials. Magnetism: Classification of magnetic materials, classical theory of diamagnetism and paramagnetism, Weiss theory of ferromagnetism, ferrites, hard and soft magnetic materials, garnets, magnetic bubbles, ceramic magnets, applications of magnetic materials

References:

1. Kittel C., *Introduction to Solid State Physics (7e)*, Wiley 1996.
2. Rao A., *A first course Solid State Physics*, Asiatech publications 2000.
3. Pillai S.O., *Solid State Physics (6e)*, New age international publications 2006.
4. Wahab M. A., *Numerical problems in Solid State Physics*, Alpha science international publications 2011.
5. Gupta H. C., *Solid State Physics*, Vikas publishing house Pvt. Ltd. 1996.

PHY 4305: MODERN OPTICS [3 0 0 3]

Optics: Review of geometrical and physical optics, Dual nature of light, Electromagnetic spectrum, Optical devices, mirrors, lenses, prisms, grating, beam splitters, zone plate, polaroids. Light sources, emission profile. Elements of lasers: Basic requirements in a laser, characteristic properties of lasers. Q-switched and mode locked lasers. CO₂, Nd: YAG lasers. Applications. Introduction to Non-linear optics. Optoelectronic devices and its application: Photo diodes, solar cells, LED, and diode lasers. DBR and DFB lasers, CCD. Optical Communication: Conceptual picture of the optical communication system, Modulation and Detection

Schemes, properties of optical fibers, discussion on device requirements, OEICS. Optical storage devices: Data recording and read out from optical discs. Holographic data storage systems.

References:

1. Ghatak A., *OPTICS (4e)*, Tata McGraw Hill Publishing Company Ltd. 2009.
2. Singh J., *Optoelectronics: An Introduction to Materials and Devices*, TATA McGraw- Hill Companies, Inc. 2014.
3. Wilson & Hawkes, *LASERS*, Prentice-Hall of India Pvt. Ltd. 1987.
4. Hugh Bennett, *Understanding Recordable & Rewritable DVD*, OSTA.org.
5. Hugh Bennett, *Understanding CD-R & CD-RW*, OSTA.org.

PHY 4306: INTRODUCTORY QUANTUM MECHANICS [3 0 0 3]

Review of certain basics: Limitations of classical physics, wave-particle duality, De Broglie's hypothesis, matter as wavepacket, Heisenberg's uncertainty principle, Mathematical Formalism: operators; commutation relation; orthonormal functions; eigenvalues and eigenfunctions; the Dirac notation; the postulates of quantum mechanics. The Schrödinger Equation: Introduction, wavefunctions, time dependent Schrödinger equation, conservation of probability, expectation values, Ehrenfest's theorem, time independent Schrödinger equation, stationary states, Schrödinger equation in one dimension: the infinite square potential well; the finite square potential well; the potential barrier; tunneling; the harmonic oscillator. Quantum mechanics in three dimensions: Schrödinger equation in spherical coordinates, separation of variables, the angular equation, the radial equation, Applications (energy eigenvalues and eigenfunctions): the rigid rotator; the hydrogen atom; angular momentum. Identical Particles. Some applications of quantum mechanics in nuclear physics, condensed matter physics, and spectroscopy: alpha decay, nanostructures, STM, vibrational and rotational spectra of molecules etc.

References:

1. Verma H.C., *Quantum Physics (2e)*, Surya Publications. 2016.
2. Gasiorowicz S., *Quantum Physics (3e)*, Wiley India Pvt Limited. 2007.
3. Jain M. C., *Quantum Mechanics: A Textbook for Undergraduates*, PHI Learning Private Limited 2012.
4. Griffiths D. J., *Introduction to Quantum Mechanics (2e)*, Pearson Education.
5. Eisberg R. and Resnick R., *Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles (2e)*, Wiley-India Pvt Limited. 2009.

Minor Specialization: Material Science

CHM 4051: CHEMICAL BONDING [3 0 0 3]

Introduction to bonding, Classification. Ionic bond- Lattice energy, Born Haber cycle, Radius-ratio rules, Properties of ionic compounds, Covalent character in ionic bonds. Covalent bond-Covalency, Valence bond theory, Sigma and pi bond, Hybridization, VSEPR Theory, Molecular orbital theory, Bond order, Properties of covalent compounds. Coordination bond - Primary and Secondary valencies, ligands, Valence bond theory of complexes, Crystal field theory of octahedral and tetrahedral complexes, Low and high spin complexes. Metallic bond-Band theory of metals, Conductors, semiconductors and insulators. Secondary bonding- Hydrogen bonding, London forces and dipole-dipole interactions.

References:

1. J D Lee, "Concise Inorganic chemistry", Wiley India, 2012
2. B R Puri , L R sharma and K C Kalia, "Principle of Inorganic chemistry", Vishal Publishing Co., Punjab, 2017.
3. D F Shriver, P W Atkins, "Inorganic chemistry", Oxford India, 2014
4. A F Cotton, "Basic Inorganic chemistry", Wiley Publishers, 2007

CHM 4052: CHEMISTRY OF CARBON COMPOUNDS [3 0 0 3]

Introduction to Organic Compounds: Classification, Nomenclature; Alkanes: Homologous series, Preparation; Cycloalkanes: Ring size and strain, Applications; Alkenes: Markovnikov and anti-Markovnikov addition reactions, Reduction, applications; Alkynes: Acidity, preparation, Reduction of alkynes, applications; Alkyl halides: SN1, SN2, E1 and E2 reaction mechanisms; Alcohols: Classification, Acidity, organo-metallic reagents; Aromatic compounds: Electrophilic and nucleophilic substitution reactions; Mechanism of some named reactions; Carbonyl compounds: aldehydes and ketones, carboxylic acids and carboxylic acid derivatives; Heterocyclic compounds: Nomenclature, synthesis and reactivity of thiophene, pyrrole and furan; Carbon materials: Fullerenes, carbon thin films, nanotubes and carbon fibers; Carbon nanotubes: SWNT, MWNT, synthesis, properties and applications; Carbon nanomaterials applications.

References:

1. B S Bahl and Arun Bahl, "Advanced Organic Chemistry", S Chand, New Delhi, 2012.
2. Robert T. Morrison and Robert N. Boyd, "Organic Chemistry", Pearson, New Delhi, 2016.
3. P.S. Kalsi, "Organic Reactions and Their Mechanisms", New Age International Private Limited, New Delhi, 2017.
4. Ashutosh Tiwari and S. K. Shukla, "Advanced Carbon Materials and Technology", John Wiley & Sons, 2013.
- B. Bhushan ed., "Springer Handbook of Nanotechnology", Springer Publishers, Berlin, 2004.

OPEN ELECTIVES

CHM 4301: ANALYTICAL METHODS AND INSTRUMENTATION [3 0 0 3]

Spectroscopic methods of analysis: Properties of EMR, General features of spectroscopy, Types of molecular spectra, Interaction of EMR with matter, Instrumentation, Applications, Theory, Instrumentation and applications of Microwave, Raman, Infrared, UV-Visible, NMR spectroscopic techniques. Chromatographic Techniques: General

concepts, Classification, Principles, Experimental techniques of CC, HPLC, TLC, GC and their applications. Electroanalytical methods: Basic principles and applications of conductometric, potentiometric titrations.

References:

1. D.A. Skoog, J. Holler, F.T.A. Nieman, *Principles of Instrumental Analysis*, 5thEdn, Saunders, Philadelphia, 1992
2. D. A. Skoog, D. M. West and F. J. Holler, *Fundamentals of Analytical Chemistry*, 5thEdn, Saunders College Publishing, Philadelphia, 1988
3. *Vogel's Textbook of Quantitative Chemical Analysis*, GH Jeffery, John Wiley & Sons Inc, 5thEdn, 1989

CHM 4302: FUNDAMENTALS OF INDUSTRIAL CATALYTIC PROCESSES [3 0 0 3]

Adsorption & Catalysis: Physisorption and chemisorption, Adsorption isotherms, Factors influencing adsorption, Adsorption of gases by solids, Adsorption from solution, Introduction to catalysis, Energetics, Catalytic cycles Solutions & Solubility: Ideal and non-ideal solutions, Raoult's law, Thermodynamics of ideal solutions, Vapor pressure and boiling point composition curves, Distillation behaviour of completely miscible & immiscible liquid systems, Azeotropes Colligative Properties: Determination of molar masses from vapor pressure lowering, Osmotic pressure, Boiling point elevation and Depression of freezing point, Vant Hoff's factor Colloids: Types, Preparation and purification of sols, General properties, Optical, Electrical & Kinetic properties of sols, stability of sols, Application of colloids, Emulsions & Gels- Types, Preparation, Properties and their applications.

References:

1. *Principles of Physical Chemistry*, B.R. Puri, L.R. Sharma, M.S. Pathania, Vishal Publications, New Delhi, (23e), 2008
2. *Principles of Physical Chemistry*, S.H. Maron, C.F. Prutton, IBH Publishing co. New Delhi, (4e), 1985
3. *Fundamentals of Analytical Chemistry*, D.A. Skoog, D.M. West, F.J. Holler, R. Crouch, (4e), Thomson-Brooks, 2007

CHM 4303: SUSTAINABLE CHEMICAL PROCESSES AND PRODUCTS [3 0 0 3]

Introduction and principles of green chemistry, Examples, Atom economy, carbon efficiency, life cycle analysis, sustainable products, process and synthesis catalysis and green chemistry, examples of fine and bulk chemicals production, catalysts for clean technology. Application of ecofriendly approach to waste treatment. Cleaner production processes, clean synthesis in lab Scale, industrial examples, use of ecofriendly energies. Bio-pesticides, polymers & pharmaceutical products. Electrochemical synthesis, Alternate reaction media using water and other green solvents, ionic liquids & supercritical fluids; phase transfer catalysis.

References:

1. P.T. Anastas, J. C. Warner, *Green Chemistry: Theory and Practice*, Oxford Univ. Press, Oxford, 2008
2. A.S. Matlack, *Introduction to Green Chemistry*, Marcel Dekker, New York, 2001
3. P. T. Anastas, R. H. Crabtree, *Handbook of Green Chemistry and Catalysis*, Wiley-VCH, Weinheim, 2009

Inter Institute Open Electives

Centre for Creative and Cultural Studies (CCCS), Manipal

IIE 4301: ART APPRECIATION [3 0 0 3]

How to read a visual, how to enjoy or feel an art form, what is Creative Thinking? Indian Art: Heritage & Culture; Art Appreciation: Western Art, Artist & Art Movements: Raja Ravi Verma, Tagore, Da Vinci, Van Gogh; Aesthetics: Beauty, Feel & Expression; Art & Science; Art & Film; Art: Freedom & Society, to be an art literate. A journey to immerse in the world of Art.

IIE 4302: INDIAN CULTURE AND CINEMA - AN INTRODUCTION [3 0 0 3]

Introduction to Idea of Culture, Identity and tradition, Indian Cultural History, Indian cultural history, Time and space, Indian Art and heritage, Indus valley civilization – Indian Independence, Post-colonial India, Modern India, Indian Cinema, Body, language and feel, Film and culture, Evolution, Interpretation and Reflection, Indian Cinema, Media and the medium, Pioneers and classical films, Culture and art of cinema, Culture, Cinema and Society, Revolutions, ideas, innovations, Culture, Cinema and Peace, Message, purpose and the challenge.

Manipal Institute of Management, Manipal

IIE 4304: CORPORATE FINANCE [3 0 0 3]

Introduction to Corporate Finance, Financial Goal, Agency Problems, Managers vs Shareholders Goals, Concepts of Value and Return, Capital Budgeting Decisions, Cost of Capital, Calculation of the Cost of Capital in Practice, Financial and Operating Leverage, Capital Structure, Relevance of Capital Structure, Irrelevance of Capital Structure, Relevance of Capital Structure, Dividend Theory, Dividend Relevance, Dividend Relevance, Dividend and Uncertainty, Dividend Irrelevance, Principles of Working Capital Management.

References:

1. Brealey, R., Myers, S., Allen, F., & Mohanty, P. (2014). Principles of Corporate Finance (11e). New Delhi: Mc Graw Hill Education (India) Private Limited.
2. Pandey, I. M. (2014). Financial Management (10e). New Delhi: Vikas publishers.
3. Ross, S. A., Westerfield, R. W., Jaffe, J., & Kakani, R. K. (2014). Corporate Finance (10e). New Delhi: Mc Graw Hill Education (India) Private Limited.
4. Parasuraman, N. R. (2014). Financial Management - A Step-by-Step Approach (1e.). New Delhi: Cengage Learning India Private Limited.

IIE 4305: INTERNATIONAL BUSINESS MANAGEMENT [3 0 0 3]

Historical perspective of international business, International business environment, Modes of entering international business, Cross-Culture and dynamic market understanding, Differences in Culture, Theories of international business, World Bank, World trade organization, Multinational Corporations and their involvement in International Business, Tariffs and quotas, Balance of Payment Account.

References:

1. Hill Charles, W. L., & Jain Arun, K. (2011). International Business: Competing in the Global Marketplace. (8e), Tata McGraw Hill.
2. Kumar, S. P., & Sanchari, S. (2012). International Business Management-AGlobal Perspective. New Delhi: Excel Books.

IIE 4306: BRAND MANAGEMENT [3 0 0 3]

Introduction to brand management, Developing a brand strategy, Brand resonance and brand value chain, Designing and implementing brand marketing programs to build brand equity, Measuring and interpreting brand performance, Designing and implementing brand architecture strategies, Managing brands.

References:

1. Keller, K. L., Parameswaran, M. G., Jacob, I. (2015). Strategic Brand Management (4e). Noida, India: Pearson Prentice Hall Publication.
2. Rowles, D., (2014). Digital Branding (1e.). UK: Kogan Page Limited.
3. Kapferer, J. N., (2012). The New Strategic Brand Management: Advanced Insights and Strategic Thinking (5e). UK: Kogan Page Limited

Centre for Integrative Medicine & Research (CIMR)

IIE 4307: YOGA [3 0 0 3]

Aim, Objectives, Meanings and Definitions of Yoga, History of Yoga, Concepts and misconceptions of Yoga, Schools of Yoga, Ashtanga Yoga

Subjects by Industry Experts

IIE 4308: HEALTH ECONOMICS [3 0 0 3]

Economics: Understanding Economics, Efficiency, Rational decision making, Opportunity costs, Supply and demand, Price discovery, Health economics: Defining health, Human capital, what does supply and demand mean in the context of health? Arrow on the uncertainty and welfare economics, The Moral hazard, DALY and QALY, Efficiency: The Production possibility frontiers. The production function for health care. Health policy, Defining equity, Standards of healthcare provision Epidemiology, The Healthcare sector, The demand for health, Disease prevalence, The pharmaceuticals market, Cross country case studies.

References:

1. Sloan, Frank A., and Chee-Ruey Hsieh. Health economics. MIT Press, 2012
2. Annemans, L. Health economics for non-economists. An introduction to the concepts, methods and pitfalls of health economic evaluations. Academia Press, 2008
3. Jeffery, Roger. The politics of health in India. University of California Press, 1988.

IIE 4309: DIGITAL MEDICINE [3 0 0 3]

Present day practice of medicine. Limitations of scalability in the present framework. Introduction to computing, algorithms, big data, semantic web, mobility. Communication-WAN/LAN, 3G/4G and 5G. Patient/Electronic Health records. Experience with these records elsewhere Wearables, the physics of data capture. Practical demonstration of wearables Genomics, an introduction. Computational genomics including the software. Imaging –an introduction-ionizing and non-ionizing. Imaging software and science of diagnosis. How all the four 4 pillars-PHR/EHR, Wearables, Genomics and Imaging come together with software as the glue to change the world of medicine.

References:

1. David Mount. Bioinformatics: Sequence and Genome Analysis. CSHL, 2001
2. Durbin, Richard, Sean Eddy, Anders Krogh, and Graeme. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press, 1999

Manipal College of Nursing Manipal

IIE 4310: MEDICAL EMERGENCY AND FIRST AID [3 0 0 3]

Principles of First Aid, First aid kit and equipment, emergency drugs, scene assessment, safety and identifying hazards, patient assessment, Basic Life Support and AED, triage, extrication/stretchers, ambulance. Describe the causes, signs and symptoms and management of respiratory emergencies, acute gastro-intestinal emergencies, musculoskeletal emergencies, dental, ENT and eye emergencies, renal emergencies, nervous system emergencies, hematological emergencies, endocrine emergencies, toxicological emergencies, environmental emergencies, pediatric emergencies, psychiatric emergencies, obstetrical emergencies

References:

1. Pollak, A.N. (2005). Emergency care and transportation of the sick and injured. Massachusetts: Jones and Bartlett publishers.
2. Keen, J. H. (1996). Mosby's Critical Care and Emergency Drug Reference. Missouri: Mosby's year book.
3. Walsh, M. (1990). Accident and emergency nursing. A new approach. Oxford: Butterworth Heinemann Ltd.
4. Sbaih, L. (1992). Accident and emergency Nursing. A nursing model. London: Chapman and Hall.
5. Sbaih, L. (1994). Issues in accident and emergency Nursing. London: Chapman and Hall.
6. Bourg, P., & Rosen, S. P. (1986). Standardized nursing care plans for emergency departments. Missouri: The C. V. Mosby Company.
7. Howard, P.K., & Steinmann, R. A. (2010). Sheehy's Emergency Nursing principles and practice. Missouri: Mosby Elsevier.
8. Sira, S. (2017). First Aid Manual for Nurses (First ed.), New Delhi: CBS Publishers & Distributors Pvt. Ltd.

IIE 4311: LIFE STYLE MODIFICATION AND COMPLEMENTARY AND ALTERNATIVE THERAPIES [3 0 0 3]

Principles and concepts of life style modification and various complementary and alternative therapies, Demonstrate skill in performing different yoga asanas, guided imagery/Progressive muscle relaxation, meditation & Pranayama, reflexology, massage therapy, aerobics, laughter therapy

References:

1. Bhat Krishna K. The power of yoga. Suyoga publications; DK, 2006
2. M.M.Gore. Anatomy & Physiology of yogic practices; (5e), New age book.
3. K N Udupa. Stress and its management by yoga. (2e). Motilal Banarsidas publishers Pvt. Ltd, Delhi, 2007.
4. Yoga and total health. A monthly journal on the yoga a way of life.
5. Swami Satyananda Saraswati. Dynamics of yoga. (2e), Bihar school of yoga, Bihar 1997.

Welcomegroup Graduate School of Hotel Administration, Manipal

IIE 4312: INDIAN CUISINE AND CULTURE PRACTICAL [3 0 0 3]

Introduction to Indian cuisine, Basic Indian gravies, Rice cooking, Preparation of various rice products, Tandoor Cooking, Indian sweets, Comfort Food, Regional and sub-regional cuisine.

IIE 4313: FOUNDATION COURSE IN BAKING AND PATISSERIE PRACTICAL [3 0 0 3]

Introduction to Patisserie and Baking Principles, Special emphasis placed on the study of ingredient functions, Students will have the opportunity to apply basic baking techniques, Understanding fundamentals of yeast dough production, Emphasis on the application of ingredient functions, product identification and recipe interpretation occurs

throughout the course, Pastry Basics and Pie dough, The fundamental production of classical European pastry based desserts are included, Techniques of Cake Making, Techniques of Cookie making, The course emphasizes the preparation and makeup techniques of various cookies.

References:

1. Wayne Gisslen – Professional Baking, (5e), John Wiley USA.
2. Haneman L.J. Bakery: Flour Confectionery HEINMAN.
3. Mermaid Books The Book Of Ingredients DOWELL PHILIP.
4. John Wiley Understanding Baking AMENDOLA JOSEPH.
5. New Age International, A Professional Text to Bakery and Confectionery, KINGSLEE JOHN.
6. Virtue And Company Ltd., The New International Confectioner: WILFRED J. FRANCE.
7. Charrette Jacques, Great Cakes and Pastries, TEUBNER CHRISTIAN.
8. Joseph Amendola, Baker's Manual, (5e), NICOLE REES.
9. Joseph Amendola, Understanding Baking, (3e), NICOLE REES.
10. Culinary Institute Of America, Baking and Pastry: Mastering the Art and Craft, JOHN WILEY.

IIE 4314: GLOBAL CUISINE & CULTURE- PRACTICAL [3 0 0 3]

European Cuisine: Familiarization of ingredients, recipes and preparation of different countries. North American Cuisine: Familiarization of ingredients, recipes and preparation of different countries. South American Cuisine: Familiarization of ingredients, recipes and preparation of different countries. Asian Cuisine: Familiarization of ingredients, recipes and preparation of different countries. Australian Cuisine: Familiarization of ingredients, recipes and preparation of different countries. African Cuisine: Familiarization of ingredients, recipes and preparation of different countries. Molecular Gastronomy: Additives, Tools, and Recipes. Processed Food: Comparison and Critiquing. Mediterranean and European cuisine: Familiarization of ingredients, recipes and preparation of different countries.

References:

1. The Professional Chef - The Culinary Institute of America
2. Practical Cookery - Kinton, Ceserani and Foscett
3. Food Production Operation - Parvinder S. Bali
4. Professional Cooking - Wayne Gisslen
5. Cookery for the Hospitality Industry - Dodgshun Peters
6. Modern Cookery - Thangam E Phillips

School of Communication, Manipal

IIE 4315: REPORTING AND WRITING [3 0 0 3]

Introduction to news writing news in different media, news, definition of news, news values; types of news other theoretical issues relating to news writing. News Reporting Basic of news writing: structure of news reports; writing the lead; the changes in the composition of the lead; techniques of news gathering; sources of news. Reporting various types of reporting (Objective, Interpretative, Investigative.) General assignment reporting/working on a beat. Reporting for news agency, periodicals and magazines. Interviewing: doing the research, conducting the interview, types and formats of interviews, writing interviews

References:

1. Mencher, Melvin (2006): News Reporting and Writing, Mac-Graw Hill, Boston.
2. Scalnan, Christopher (2000): Reporting and Writing: Basics for the 21st Century, Harcourt College Publishers.
3. Harrington Walt (1997) Intimate Journalism: The Art and Craft of Reporting Everyday Life, Sage Publications.
4. Carole, Rich (2007), Writing and Reporting News: A Coaching Method, Thomson Learning Inc. Kamath, K.V. (1993): Journalists' Handbook, Vikas Publishing House.
5. Aggarwal, Vir Bala (2006): Essentials of Practical Journalism, Concept Publishing Company.

IIE 4316: INTRODUCTION TO ADVERTISING & PUBLIC RELATIONS [3 0 0 3]

Introduction to advertising; Evolution and history of advertising; Influence of advertising on society and ethics. Advertising as part of marketing mix; Structure and types of ad agencies; Advertising planning; creative strategy and implementation (media strategy). The essentials of advertising on different media platforms – print, broadcast, internet and new media; discuss the difference in planning and execution using examples or campaign case studies. Public Relations-scope; definition; evolution; establish difference between PR and advertising; Identifying stakeholders and various Public Relation tools. Steps in developing a PR program/campaign-stating the problem, planning and programming, action and evaluation; Crisis communication; Ethical issues in Public Relations.

References:

1. Butterick, K (2012): Introducing Public Relations: Theory and Practice. New Delhi: SAGE Publications India Pvt. Ltd.
2. Cutlip, Center & Broom, (2000): Effective Public Relations.USA: Prentice Hall International.
3. Jaishri Jethwaney and Shruti Jain, (2012): Advertising Management. New Delhi: Oxford University Press
4. Reddi, C.V.N. (2009): Effective Public Relations and Media Strategy. New Delhi: PHI Learning Pvt. Ltd.
5. Sharma, S. & Singh, R. (2009): Advertising Planning and Implementation. New Delhi: PHI Learning Pvt. Ltd.

IIE 4317: BASIC PHOTOGRAPHY [3 0 0 3]

Photo Journalism: History of Photography and Photo Journalism. Photo Journalism: Definition, Nature, Scope and Functions of Photo Journalism – Qualification and Responsibilities of Photo Journalists, News Photographers and News Value, Types and Sources. Selection, Criteria for News Photographs – Channels of News Pictures – viz., Wire, Satellite, Agency, Stock, Picture Library, Freelancer, Photo Editing, Caption Writing, Photo – Presentation. Legal and Ethical aspects of Photography – Professional Organizations – Camera – Components and Types of Camera – Types of Lens, Types of Films, Types of Filters – Importance of Light and Lighting Equipments – Camera Accessories – Picture appreciation. Digital Camera – Digital Technology and its future – Darkroom Infrastructure – Film developing and Printing

References:

1. Basic Photography – Newnes
2. The Hamlyn Basic Guide to Photography – Hamlyn
3. Hamlyn Encyclopedia of Photography – Hamlyn
4. Photographing People – Guglielmezei
5. History of Photography – Cyernshem G R
6. Photo Journalism – Rothsteline
7. Techniques of Photo Journalism – Milten Feinberg
8. Freelance Photography – Jechsend Gedsey
9. Picture Editing – Stanley E Kalish and Clifton C Edom
10. News Photography – Jack Price
11. 1000 Ideas for better News Picture – High Sidley and Rodney Fox

IIE 4318: MEDIA PRODUCTION TECHNIQUES [3 0 0 3]

Print design elements – typography, colours, spacing, pictures, logos, graphics, principles of layout and design – basic writing skills. Photography – SLR camera, Lenses, Apertures and Shutter speeds, Exposure, Understanding light, Filters and accessories, composing a picture, developing and printing, creating special effects. Digital photography – digital camera – digital technology and its future. Television – Introduction to AV Media-pre-production, production, post-production. Show packaging-Camera-characteristics, parts and

functions; Mounting accessories and movements. Shots-Types and Uses; Basic composition. Practical video recording process. Radio – Introduction to Radio-Microphone types, characteristics and uses; Cables and Connectors. Recording device-Types and Characters, Audio editing, Programme formats-news, drama, feature and PSA's and Advertising.

References:

1. Gerald Millerson, “Effective TV production”
2. Peter Jarvis, “The Essential TV director's Handbook
3. Hamlyn “Basic guide to photography”
4. Ralph Milton “Radio programming – a basic training manual”
5. Tomlinson Holman “Sound for film and television”
6. Reporting and writing by Melwin Mencher

IIE 4319: GRAPHIC & SKETCHING [3 0 0 3]

Basic Art Principles: Element of Art & Design, Contour Drawing, Composition Principles, Pencil shading, creating geometry model and shading. Basic Perspective: Still life sketching & Drawing, Styles of shading, Introduction to colors, color still life painting, Layout Design, Creating concepts for Design. Skeleton System, Body Proportions, Upper Body, Lower Body, Back, Hands and Legs. Text: Human Anatomy by Victor Perard, Dynamic Anatomy by Burne Hogarth. Gesture Drawing Tips, Line of Action, Dynamic Poses, Body Weight and Gravity, Clothing. Text: Figure Drawing by Anthony Ryder.

List of Practical's:

- ▶ 10 Drawings of Human Anatomy Study In Pencil
- ▶ 50 Drawings of Gesture Drawing In Pencil
- ▶ 5 Contour Drawing
- ▶ 2 Still Life Pencil Shading
- ▶ 2 Color Still Life
- ▶ 2 Layout Design

References:

1. Mastering Composition: Techniques and Principles to Dramatically Improve Your Painting (Mastering (North Light Books)) Hardcover – 25 Jan 2008 by Ian Roberts
 2. Layout Essentials: 100 Design Principles for Using Grids (Design Essentials) Paperback – 1 by Beth Tondreau
 3. Pencil Drawing: Learn how to develop drawings from start to finish with techniques for shading, contrast, texture, and detail (Artist's Library) Paperback – 1 Jan 1988 by Gene Franks
 4. Drawing the Head and Figure – Jack Hamm
 5. Dynamic Anatomy – Burne Hogarth
 6. The artists complete guide to Human figure Drawing – Anthony Ryder
 7. Human Anatomy – Victor Perard
-